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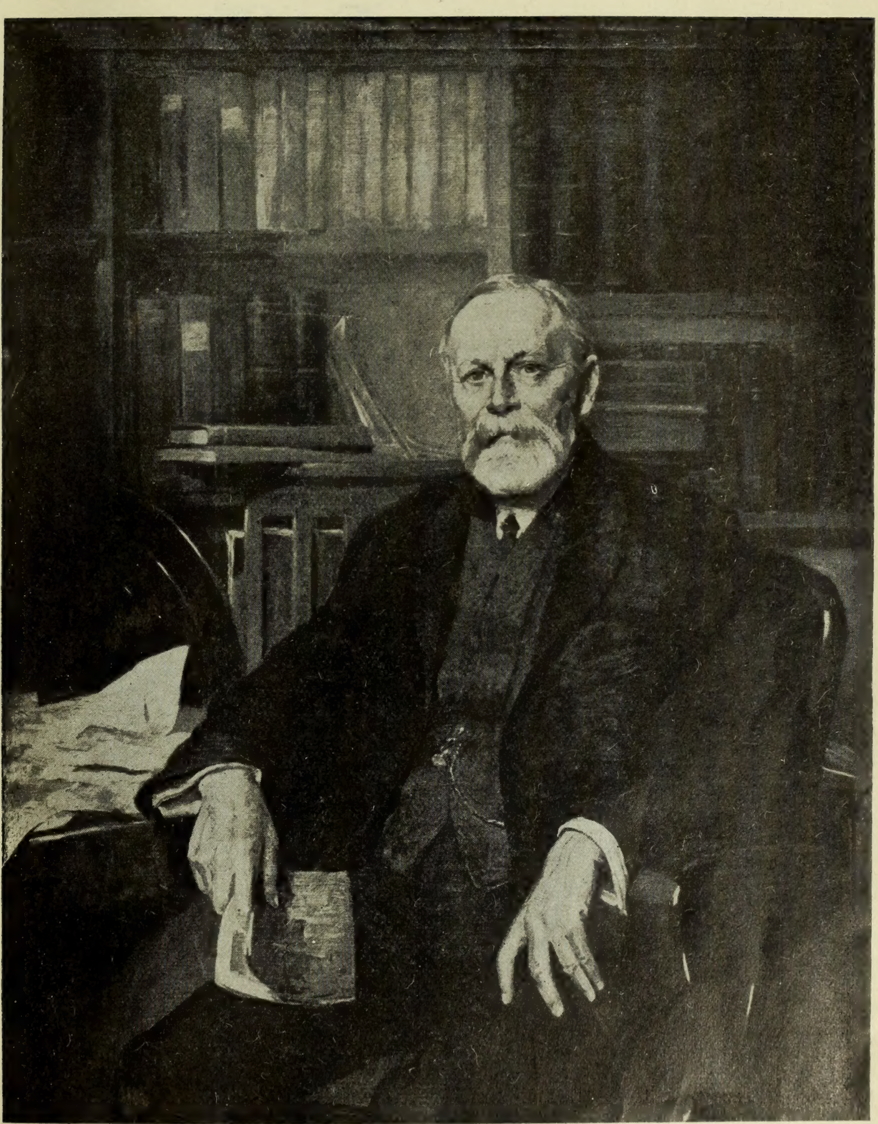

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The Transactions & yearbooks
of
The University of Toronto Engineering Society

With which is incorporated the Applied Science

PUBLISHED BY THE SOCIETY

PREFACE

THIS IS THE FIRST issue of the TRANSACTIONS since the birth of *Applied Science* as a monthly in 1907. It is the first publication of the Society since the last issue of *Applied Science* in 1916. Therefore, if it does not meet the standard set by our predecessors may those who come after profit by our shortcomings, and remember that all things have to have a start.

Toronto, April 15th, 1921.

...Foreword...

by

OUR DEAN

The Engineering Society is in a period of transition. Through all its history its main function has been the presentation of papers of interest and use in Applied Science and Engineering, and one of its duties to both the graduate and undergraduate body has been the publication of these papers. Throughout the war this process was much interfered with, and the excellent publication, "Applied Science," which was so popular before the war, was necessarily discontinued.

The publication of the Society's transactions is now being resumed, but in the interval since pre-war days the Society has expanded and has so considerably altered its constitution, embracing its various sections, that the nature of the proceedings and the Society's activities are much more comprehensive, and the published transactions will in consequence be much enhanced in value. This present volume ought to prove of considerable value to students and graduates alike, and the Society is to be congratulated on its production.

The Engineering Society has indeed become a most important factor in the University and the student activities of the Faculty of Applied Science. It is fortunate that such is the case at this particular time, when the Faculty is in its growing period, and during the revival after the war, because the success of both Faculty and Society are bound together.

The Engineering Society, with its new constitution just adopted, is entering upon a new cycle, and with its various interests and objects will have an increasing influence with the students in this Faculty. With the increase in numbers and the greater scope of work being planned for the Faculty, the Society will go forward afresh. But it will advance just in proportion to the energy, the initiative, and interest displayed by the members, and their activity will be the measure of its success. The various forms of work in and for the Society are nowadays a part of Engineering Education, and it is important that all members take an interest in the Society's work in this respect.

The authors, officers, and others concerned in the preparation and publication of this very interesting collection of papers are to be complimented upon their subject matter and excellence, and it will be recognized that this volume of the Society's transactions will be an index of the success and very flourishing condition of the Society during the past year.

C. H. MITCHELL,
Dean.

March 1921.

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THE TRANSACTIONS of the
University of Toronto
Engineering Society
WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 34 TORONTO, APRIL 15, 1921 1920-21

APPLIED SCIENCE AND RECONSTRUCTION

Dean Mitchell's Opening Address to the Engineering Society, October 7th, 1920.

DEAN MITCHELL opened his address by pointing out the present insistent call for science and applied science, not only in Canada, but throughout the world.

Although the war set Canada back on the road of progress by six years, yet applied science has been given an enormous impetus by the war,—and we have emerged from it with the consciousness that life to-day is a scientific life.

The importance of the University training of young engineers and scientists can hardly be overstated, but a man must be prepared to humble himself at the end of his University course, and to enter his chosen field at the very bottom. This is essential, but the early training of the University added to the immediate training which a man gets in his profession or business career is bound to make him succeed in the end, and to a degree beyond the possibilities of an untrained man.

We are now starting afresh after the war; we ourselves have much lost time to regain, but when we see the turmoil that still exists in Europe we realize keenly that it is only by applying all our energies, whether scientific or otherwise, to keeping things on an even keel in Canada that we can win out in the next few years of reconstruction.

In this process of reconstruction, the application of science is coming and must come to the rescue. And what can science and applied science do for Canada at this particular time? Canada has immense resources from the fisheries of Nova Scotia to the timbers of British Columbia,—and she has human resources as well.

Her human resources have been exemplified beyond any criticism in the last five years of war, and by Canada's part in the Empire. Her human resources are now well proved. But although part of my work as Dean of this faculty deals with human resources what I want more particularly to deal with this afternoon is the material resources of Canada. I do not wish to merely list our undeveloped resources, but to show the activities

by which these resources are now being developed by the application of science.

Let us glance at the railways. We are considering building two lines of railways to open up the iron mines and the timber limits of James Bay. Without saying anything to commit me, you all know that there is at present a large project talked of in Ontario concerning electric railways.

Speaking of transportation, the activities in road-making are pronounced in all the Provinces, owing largely to motor car traffic. As for water transportation, tens of millions of dollars are being spent upon the Welland Canal, and people are talking of a St. Lawrence deep waterway. Dry docks are being built in the East and West and on the Great Lakes. Harbors are being deepened and improved.

Now we come to power. Ontario is not the only Province that is planning and executing large power projects. Almost all the Provinces have some power development schemes on hand.

Time does not permit of even mentioning the many other public utilities. We will now touch upon our industrial life. We have many shipbuilding concerns,—mostly steel; we have large steel resources which we can soon develop electrically; new flour mills are being built.

Immense resources of crude oil are being found in Northern Alberta; Canada is refining her own sugar—there are at least two huge sugar refineries on the Atlantic Coast.

Turn for a moment to articles of cement, rubber and leather, which are being developed at a great rate. The most active economic industry is that of paper. People are building paper and pulp mills all over the country.

There are billions of dollars worth of low grade iron ores, copper, and nickel in Northern Ontario awaiting development. The area of Northern Manitoba and Eastern Saskatchewan is amazingly rich in gold, silver and copper.

The chemical industry developed by the war is turning its hand very successfully to the production of industrial chemicals. At Trenton they are making acid phosphate; at Shawinigan, acetic acid, while in Saskatchewan synthetic Epsom and Glauber's salts for the treatment of leather are being made from the alkalies of the prairie. Attempts are being made to briquette the low grade lignite coal of the prairies. This is now a proved success.

Now I have run through all this category of the activities of our material resources, and in closing I can only say, that it is by the education of our human resources and the application of scientific methods that the development of the country can proceed. And with the development along these lines we can see before us the winning of our war of reconstruction; and to that I am sure we are all looking forward as an opportunity for great public service on behalf of our country and our Empire.

SIR KENELM DIGBY'S THEORY OF LIGHT*

By WILLIAM RENWICK RIDDELL, B.Sc., LL.D., Etc.,
Justice of the Supreme Court of Ontario.

SIR KENELM DIGBY, born 1603, was one of the best known and most admired philosophers of his own day and those immediately succeeding. He is quoted approvingly by many writers during the 17th and 18th centuries, but is now more than a name only from his amazing "power of sympathy." The disrepute into which this curious medicament fell brought ridicule upon its advocate and has had a disastrous effect upon his reputaton—a disaster almost wholly undeserved.

He was an acute philosopher as philosophy was then understood, well read in the Greek writers, particularly Aristotle, and in Bacon, Descartes, Galileo, Gilbert and Harvey. He was an accurate observer of the phenomena of nature, but hardly a success in his experiments.

Educated at Oxford, which he left without a degree, he spent some time in France and Italy, and was subsequently employed at Court. He took out letters of marque and had considerable success over the French, Spaniards, and Venetians. He was one of the most noted of English Catholics, and was Chancellor to Queen Henrietta Maria; he was banished in 1649, and for four years lived most of the time in Paris, busy with his chemical experiments. He made his peace with Cromwell and lived, from 1653 until his death in 1665, in England, a Fellow and on the Council of the Royal Society at its institution in 1663. He died in 1665 and lies buried in Christ Church, Newgate (1).

His chief philosophical work is entitled "Of Bodies and of Man's Soul"; it is composed of two parts, and first appeared in Paris in 1644 (2).

The work was written for his son Kenelm and was intended to deal chiefly with his "main great theme, the Soul" and its immortality, the discussion of bodies, though the greater part being really introductory and subsidiary (3).

It is in the first part that his theory of light is to be found. At this time there was still some remains of the age-old dispute as to the nature of light—the favorite theory, being that of the Pythagoreans and Platonists, that it consists of exceedingly minute but still material particles, propelled longitudinally from the surface of the body seen and striking the eye (4). Aristotle held that light was an "activity" (energeia), i.e. what Digby calls a "quality" which is analogous to the meaning of Tyndall when he calls heat a "mode of motion."

He begins his treatise with "Quantity (5) among those primary affections which occur in the perusal of a Body;" he shows that this is "Extension" expressed by a determinate number of lesser extensions of the same nature and "therefore noth-

*Paper presented to the Engineering Society, November, 1920.

ing else but divisibility;" and he declares that it is impossible that it is composed of "points of indivisibility."

With the almost universal confusion of his times he does not accurately distinguish between a body and its qualities—between number as such and extension—and the like; but his argument is easily followed:

He proves that indivisibles cannot make quantity—or to employ our modern terminology, the parts, however small into which matter can be divided, are not indivisible—that is matter is always matter and never "a Monad having position." His proof is taken from Euclid's Elements, Book VI., Prop. 10, by which "Euclid hath demonstratively proved beyond all cavil that any line whatever may be divided into whatever number of parts—an hundred, a thousand or a million.

Digby meets and answers various objections—some wholly metaphysical and none requiring notice here.

Then after a discussion of rarity and density (6) and the bodies possessing these qualities, for he considers them two distinct qualities (as were in his view heat and cold, wetness and dryness, etc.), he attacks the opinion of some philosophers that rarity is produced by the mixtion of "vacuity" among bodies—in our modern terminology, that the ultimate molecules of matter are of the same weight and the mass of matter in a body depends on the nearness of the molecules to each other. He quotes against this view Aristotle's dictum (on the fourth book of his Physics) that there can be no motion in vacuo, but admits that Aristotle may be speaking of a "vast inanity," and not so little ones as no body whatever can come to, but will be bigger than they." His chief argument is this—Galileo gives water 400 times heavier than air, Marinus Ghetaldus gold 19 times heavier than water, therefore gold is 7600 times heavier than air—consequently if the deprecated theory is sound "air will . . . appear to be like a net whose holes and distances are the lines and threads in the proportion of 7600 to 1; which were too great an absurdity to be admitted" (7). Why, Digby does not say.

This is a fair sample of much that passed for scientific proof at the time.

Having now, as he thinks, quite established the innate qualities of Density and Rarity, he defines his terms, "we may with reason call those things dense wherein a man finds a ***sensible*** difficulty *to part* them, and those *rare* wherein the *resistance* is imperceptible."

He then proceeds to apply gravity or weight to produce the "four first bodies called elements." Gravity with density produces wetness and dryness—when gravity works more effectively than density it forces the parts of the body to "turn to the centre, so become fluid and moist," but if in "weighing rarity against gravity it happen that the rarity overcame the gravity, then the

gravity will not change the figure . . . but what figure it has from its proper natural causes the same will still remain. . . . and consequently such a body will have terms of its own and not require an ambient body to limit and circle it in, which nature we call dry." While the quality of a body which "the more easily receives its figure from another (containing it and circling it) we attribute to wetness and moisture." In a word a body which stands by itself and can maintain its form is dry, but one which cannot is wet. Dense bodies are not necessarily dry nor rare bodies wet, but "heat is a property of rare bodies and cold of dense ones." This is assumed and stated without any, even the semblance of, proof.

Digby is puzzled by the paradox that of dense bodies the less dense is the more cold, but of two rare ones the less rare is the less hot—his terminology prevents him appreciating that the two statements express the same thing differently worded.

Now he comes to grips with the elements and is convinced by what to our modern thought is an extraordinary piece of sheer empty verbiage that "the number of elements assigned by Aristotle is truly and exactly determined by him; and there can be neither more or less of them. . . the conjunction of gravity with these two (i.e. rare and dense bodies) breeds two . . . sorts of combinations, each of which is . . , twofold . . the one extremely hot and moderately dry . . . another extremely humid and moderately hot . . , another extremely cold and moderately wet and another extremely dry and moderately cold. . . Fire, Air, Water and Earth" (8). These elements are again compared thus, "What makes itself and other things be seen as being accompanied by light, is called *fire*; what admits the illuminative action of fire and is not seen is called *air*; what admits the same action and is seen . . . is called *water*; and what through the density of it, admits not that action, but absolutely reflects it, is called *earth*" (9).

He adds to the difficulty of our understanding precisely what he means—if he had any clear idea at all—by saying that though he had pitched on the four bodies of fire, air, water and earth, "it is not my intention to affirm that those which we ordinarily call so and fall daily within our use are such as I have expressed them; or that these philosophical ones . . have their residence or consistence in great bulks in any places of the world be they never so remote—as fire in the hollow of the moon's orb, water in the bottom of the sea, air above the clouds, and earth below the mines. . . These notions are only to serve for certain ideas of elements by which the forenamed bodies and the compound of them may be tried and receive their doom of more or less pure and approaching to the nature from whence they have their determination. And yet, I will not deny that such perfect elements may be formed in some very little quantities

in mixed bodies, and the greatest abundance of them in these four known bodies that we call in ordinary practice by the names of the pure ones, for they are least compounded and approach most to the simpleness of the elements."

To use the Platonic term, "idea," enables us to translate this into modern language thus:—

"What I have called fire, air, water and earth are not really what are generally so called; but certain matter existing only in theory (speaking generally), the terminology is employed for convenience only, and to indicate the quantity of heat and fluidity possessed by a body. There may, indeed, be certain small ingredients of a body with the ideal quantity of heat and fluidity, but such is not to be expected in great quantity anywhere."

This thought every now and then escapes Digby; but he has it generally, if only subconsciously or unconsciously, and it must not be lost sight of by anyone desiring to comprehend his philosophy.

Comparing the elements, he finds fire more active than water or earth, "as will appear clearly if we consider, how, when fire is applied to fuel and the violence of blowing is added to its own motion, it incorporates itself with the fuel, and, in a small time converts a great part of it into its own nature and shatters the rest into smoke and ashes.

All which proceeds from the exceedingly smallness and dryness of the parts of fire, which being moved with violence against the fuel and thronging in multitudes upon it, easily pierce the porous substance of it like so many extremely sharp needles (10). Here we have a new assumption, viz., that the ultimate particles of fire are exceedingly small—nothing so far has been said to indicate that they are smaller than those of any other element, but the alleged fact continues to be tacitly assumed.

And now he attacks the problem of light. He refuses to follow Aristotle in his view that light is a "quality," denying it any bodily subsistence, although there has followed him almost all the world ever since."

Digby confesses that he does not know what philosophers ordinarily mean by "qualities," and he is confident "neither do they;" and a modern can sympathize with him, for these so-called philosophers made a quality a sort of entity, distinct from the body it accompanied, and yet denied it a subsistence.

The gastric juice digested the food by virtue of a quality of digestion it had; water flowed by virtue of a quality of fluidity, medicine healed by the virtue of a quality of healing, etc., etc.

Digby considers that heat is nothing, but the very substance of fire, "a continual stream of parts issuing out of the main stock of the same fire that enters into the wood and by its rarity makes its way through every little part and divides them," a conception

as alien from our own modern ideas as that of the philosophers with whom Digby disagrees.

He boldly asserts that light is not a quality (11) and converts the arguments, five in number, of those who hold the view that it is a quality and not a substance. The first is that it illuminates the air in an instant and therefore cannot be a body, for "a body requires succession of time to move in, whereas light seems to spread itself over the whole hemisphere in an instant;" the second, that two lights can be in the same place, while no body can admit another into its place without removing therefrom; the third, that if light is a body it can be none other than fire, "the subtilest and most rarefied of all bodies whatever, and must be accompanied with heat; the fourth, the sudden extinction of fire, for "what becomes of that great expansion of light that shined all about when a cloud interposes itself between the body of the sun and the streams that come from it?" and the fifth, that if light were a body it would be shaken by the winds and by the motion of the air. As to the two first objections Digby rightly conceives them to be contained in substance in the third, because they are based upon peculiarities wherein light has a resemblance to fire, and as to the third he says that light is fire—not, indeed, fire in every form or fire joined with every substance that expresses itself by light, but fire extremely dilated and without mixture of any gross body. And as fire, so light is corporeal. He supports this statement by an extraordinary argument:

> "Let me hold a piece of linen or paper close by the flame of a candle and by, little by little, remove it further and further off; and methinks my very eye tells me, that there is upon the paper some part of that which I see in the candle, and that it grows still less and less as I remove the paper further from it; so that if I would trust my sense, I should believe it as verily a body upon the paper, as in the candle, though infeebled, by the laxity of the channel in which it flows."

Plainly he takes the light reflected from the linen or paper for a material deposit upon the linen or paper! Having persuaded himself by arguments of no greater validity than that just mentioned" "of the corporeity of this subtile thing," light, he proceeds to answer the third objection, that if light were fire it must heat as well as enlighten, by saying that "there's no dobut but it doth so as is evident by the weather glasses and other artificial musical instruments as organs and virginals which Cornelius Drebbel (that admirable master of mechanics) made to show the King, all of which depends upon the rarefaction and condensation of some suitable body conserved in a cavity within . . . . the instrument (12). He thinks the ancient miracle of Memnon's statue which sang at sunrise was "a juggle of the Ethiopian priests made by the like invention." (13). Our bodies, indeed, do not

always feel the heat, for we cannot feel heat unless it be greater than that which is in our sense, and "it is very possible that an exceedingly rarified fire may cause far less impression of heat than we are able to feel."

He compares "dilated fire" with "dilated water," when a basin of water is converted into steam, the "virtue of wetting" is reduced in proportion as the basin is less than the room; and so with dilated fire. "As dilated water may be again condensed, so dilated fire may, by the aid of glasses, be condensed to as much as it is (for example) in the flame of a candle, and then that fire or compacted light will burn much more forcibly than so much flame." This very experiment of the Burning Glass Digby considers to prove conclusively that light is fire and "nothing but fire in its own nature and exceedingly dilated."

Having now, as he thought, satisfactorily answered the third objection, he proceeds to the fourth, which asks what becomes of the light when it dies by the intervention of a cloud or the like. The adversary says that he might believe light to be fire if after it went out there were "any ashes remaining, but experience assures us, that after it is extinguished it leaves not the least vestige behind it of having been there."

The objection he rather evades than answers, he asks the adversary to tell "what becomes of the body of a flame which is continually dying, and being renewed by fresh fuel and leaves us no remainder behind it," and "when he hath well considered this, he will find that one answer will serve for both."

Digby is too honest to accept support for his theory from an experiment—a nobleman of much sincerity and a "singular friend" of his told him, that by means of glasses of peculiar construction and arrangement he had seen the sunbeams gathered together and precipitated into a brownish or purplish red powder, in some days nearly two ounces. Digby believes that the substance deposited was something which came along with the sunbeams and no part of them—we would say it was a simple swindle, especially when we learn that the powder was a "magistry" or a philosophers' stone "of a strange volative nature," which could pierce into gold itself in a very short time (14). And he is justly incredulous of the perpetual lamps with incombustible lights, alleged to have been found in tombs—before he undertakes to explain that he wants to see them "undoubtedly proved"—a wise precaution which certainly relieved him from any explanation.

He now returns to the second objection, based upon what we call the impenetrability of matter, viz., that two bodies cannot occupy the same place at the same time, whereas the sunbeams enlighten all the air and the light from two or more candles is everywhere in the same room. So far as the air is concerned, the answer is easy. The air, being a light divisible body, yields without resistance as much space as is requisite for light. It is

not at all necessary that the light should be in "every point or atom of air, but to make us see it everywhere it suffices that it be in every part of the air which is as big as the black or sight of our eye (15), so that we cannot set our eye in any position where it receives no impression of light," which is pretty bad logic, but he supports it by a most ingenious argument. The motes seen in a sunbeam sent through a cranny do not admit the light within themselves, but reflect it—still, immovable as they are, they do not prevent one seeing through the air; and consequently *a fortiori*, those parts of the air which are not penetrated by light cannot be supposed to check our vision.

Then as to the supposed fact of two or more lights in the same place, he treats of the exceeding minuteness of the particles of light. A great mathematician not named in the text, but identified in a note as Willibrod Snell (16) had calculated that the flame from gunpowder was 125,000 greater in extension than the gunpowder, and therefore might pass 125,000 rays of light in the space of the least part of gunpowder, which would be absolutely invisible to us on account of its minuteness.

"Wherefore seeing that one single light could not send rays enough to fill every little space of air that is capable of light . . . it is obvious enough to conceive, how, in the space where the air is, there is capacity for the rays of many candles."

Digby postpones his answer to the fifth objection, in order to deal with what he considers the most powerful objection to the corporeity of light, that is, "that its motion is performed in one instant and therefore cannot belong to what is material and clothed with quantity" (extension). He refers to the ring of light seen when children whirl round the firesticks to prove that the motion of light cannot be descried, and that indeed no argument can be made from thence to prove that light is not a body" (17). The question is then asked why light travelling with a great velocity does not shatter all substances, including the air. The answer is that three things concur to make a percussion great, the bigness, the density, and the celerity of the body moved, and of these, light has only one, namely celerity. He speaks of motes of the air which we see but cannot feel, the falling of a straw on one's head, etc., etc., and then makes an elaborate calculation to determine the density of the light of the sun.

"Then density of the light we have here on earth is to the density of that part of fire which is the sun's body, as the body of the sun is to that body, which is called Orbis Magnus (whose semidiameter is the distance between the sun and the earth) which must be in subtriple (18) proportion of the diameter of the sun to the diameter of the great Orbe."

Galileo (19) makes this one to 106,000,000, and applying Snell's computation of the relative density of flame and gunpowder, it at once appears that a grain of light at the earth must

be 106,000,000 times rarer than the flame at the sun, and consequently 125,000 x 106,000,000 or 13,250,000,000,000 times rarer than gunpowder. This is full of absurdities; not to say anything of the very serious error in the ratio assumed, or of the relative density of gunpowder and flame (which might pass in the existing state of pneumatics) it should have been obvious even to Digby that he was assuming that the rarity of light was uniform throughout the half-sphere of the Great Orb, while his own method would prove that the nearer to the sun the less the rarity of light. On his hypothesis it was impossible that the rarity of light could be uniform, and this impossibility was the basis of his computation. Compared to this glaring absurdity, his assumption that the light came from the whole of the half-sphere of the sun, and not simply from the surface is as nothing, even if the mistake were not pardonable in the existing state of science.

It is obvious that the true ratio of the "rarity" of light (assuming Digby's other propostions) at the sun and at the earth is not the triplicate but the duplicate ratio, the ratio not of the cubes but of the squares, of the radii of the great orb and sun reducing the ratio to about 28,000,000,000 to one (20).

Digby, having now proved that a grain of gunpowder is 13,250,000,000 times as heavy as a "ray of light as big as a grain of gunpowder," he asks "what degree of celerity light must have, more than a grain of gunpowder, to recompense the excess of weight which is in a grain of gunpowder, above that which is in a ray of light as big as a grain of gunpowder?" He indulges in an extraordinary computation to find the ratio of the semi-diameter of the *orbis magnus* (i.e., the distance of earth from sun) to the semi-diameter of a grain of gunpowder, and taking 60 grains of gunpowder to the inch, he finds that the semi-diameter of the *orbis magnus* would contain 9,132,480,000,000 grains of gunpowder (21)—or as he says, "there will be in it but 9,132,480,000,000," and adds, "whereas the other calculation makes light to be 13,250,000,000,000 times rarer than gunpowder which is almost ten times a greater proportion than the other." This has no possible meaning. I have tried to enter Digby's mind to find out what he meant to say, or what he thought he was saying, but have failed. It is impossible that he could have had any definite meaning, and this part of his book is so much idle verbiage. He affects to be determining the speed of light as compared with the "speed of gunpowder"—whatever that may be, and what he finds is the number of grains of gunpowder which would lie upon a semi-diameter of the earth's orbit. What that has to do with the relative speed no one can tell, and what is meant by saying that one ratio is "ten times greater than the other" is a mystery. The statement is untrue, and if true could have no relevancy.

However, he thinks he has proved that the extra velocity of light does not counterbalance its extreme lightness and conse-

quently infers that "it is impossible that a ray of light should make any sensible percussion, though it be a body" (22).

Now he turns to the last objection, viz., that light is not "fanned by the wind," as it was contended it would be if it were a body. His answer is an extraordinary bit of logomachy, and as a sample I here transcribe it:

> "As for the first part, we see that, when a body is discern'd now in one place, now in another; then it appears to be moved. And this we see happens also in light; as when the sun or a candle is carried or moves, the light thereof, in the body of the candle or sun, seems to be moved along with it. And the like is in a shining cloud or comet.
>
> But, to apply this to our purposes: We must note, that the intention of the objection is, that the light which goes from the fire to an opacous body far distant, without interruption of its continuity, should seem to be jog'd or put out of its way by the wind that crosses it. Wherein the first failing is, that the objector conceives light to send *species* to our eye from the midst of its line; whereas with a little consideration he may perceive that no light is seen by us but that which is reflected from an opacous body to our eye; so that the light he means in his objection is never seen at all. Secondly, 'tis manifest that the light which strikes our eye, strikes it in a straight line, and seems to be at the end of that straight line, wherever that is; and so can never appear to be in another place; but, the light, which we see in another place, we conceive to be another light. Which makes it again evident that the light can never appear to shake, though we should suppose that light may be seen from the middle of its line; for no part of wind or air can come into any sensible place in that middle of the line with such speed, that new light from the source doth not illuminate it sooner than it can be seen by us; wherefore it will appear to us illuminated, as being in that place; and therefore the light can never appear shaken. And lastly, it is easier for the air or wind to destroy the light than to remove it out of its place, as that we should see it in another place; but if it should remove it, it would wrap it up within itself and hide it."

Digby concludes his discussion of light by saying that "fire is the most rare of the elements and very dry .. .. that it may be cut into little pieces .. .. .. it multiplies extremely in its source; it must of necessity follow that it sends out in great multitudes little small parts into the air and other bodies circumfused with great dilation in a spherical manner . . . these

parts are easily broken and new parts still following the former are still multiplied in straight lines from the place where they break . . . that it must in a manner fill all places, and no sensible place is so little but that fire will be found in it if the medium be capacious . . fire must of necessity do what experience teaches us that light doth. That is to say in one word, it will show us that fire is light. But if fire be light, then light must needs be fire. And so we leave this matter."

SWITCHBOARDS*

By S. E. M. Henderson

I PROPOSE to divide this talk into two sections, the first part, consisting chiefly of a number of lantern slides, illustrating some of the engineering features, and the second part covering, in a general way, the commercial aspect of the work from the manufacturer's standpoint.

The term "Switchboards" is applied to a piece of control equipment that shows wide variations in structure and appearance, and which is used for a wide variety of purposes. In North America this control equipment is called "Switchboards," in Europe, "Switch gear," but neither term is truly descriptive, because, in both cases, the equipment involves not merely switching but also control, protection and measurement. This means that a great many individual pieces of apparatus and material (probably 3,000 or more) are used in making up the various kinds of Switchboards, and consequently the subject is an extensive and complicated one. The lantern slides will show only a few of the more important parts.

Coming now to the second part of the talk, we will leave the physical aspects and consider some of the commercial features. Switchboards and Switchboard Apparatus, like all other material made by our Company and other Companies, are made to be sold at a profit, with a view to paying dividends on the money invested in the business. This is the primary object, but many features of more or less importance have a bearing on the final results. So far as the general principles are concerned, selling switchboards at a profit is the same as selling generators, sugar, transportation, personal services or any other tangible or intangible asset. Numerous books on selling and salesmanship are available, giving analyses of the different steps involved in making a sale, describing the psychological processes on the part of the buyer and seller and covering the entire proceedings from all angles. Therefore, it is only necessary to cover here certain

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details that apply to switchboards and some other devices in particular, rather than to all commodities.

To begin with, orders are obtained or lost on the basis of price, quality, shipment, service, or a combination of two or more of these features. Many years ago, sales were often influenced or determined by other considerations, such as lavish entertainment, including plenty of liquid nourishment, enthusiastic misrepresentation of the apparatus and even direct or indirect bribery. To-day, however, the situation is fortunately radically different, and you will find that both sellers and buyers are doing and encouraging business on the basis of price, quality, shipment and service. This change is important and basic, because the bulk of any established manufacturer's business today involves dealing with the same customers day after day, week after week, and year after year, with a relatively small proportion coming from new customers. Hence maintaining good relations is probably even more important than developing good relations.

Having in mind the basic principles just outlined, it becomes evident that the term "commercial" as applied to business today, is a very broad one and cannot be limited to the activities of the salesmen. As a matter of fact, every individual connected with a manufacturing organization has an influence on the commercial aspects of the business.

Starting with the Designing Engineers, who generally look on themselves with pride as being purely Engineers rather than Commercial men, we find that they design the apparatus which is used to make up Switchboards. As the design is a controlling factor in determining cost and quality and an important factor as regards time required for manufacture, it is evident that the Designing Engineers are closely connected with at least three of the direct causes of making or losing a sale.

Considering the Production Department, Stores Department, Test and Inspection Department, and the factory itself as a group, we again find a very close connection with the four commercial features. This group is responsible for selecting of good materials and providing good workmanship, both of which items enter largely into the matter of quality. It is the controlling factor as to time required for shipment. Labor, being a considerable portion of the total cost of a device, the group is also directly related to the question of price. Price is also partly determined by the cost of raw materials for which the Stores Department may be responsible though, in the larger organizations, it is customary to have a separately organized Purchasing Department. None of the Departments mentioned in this group are ordinarily considered as Commercial in any sense of the term, and yet it is evident that they have a very important bearing on the Commercial success of any manufacturing organization.

A Manufacturing Company usually consists of three main divisions, the Factory, the Head Office and the District Sales Offices. The first has been considered separately already, there being relatively little overlapping between it and the other two divisions. The Head Office, of course, includes the Executive Staff, which determines the general policy of the Company and controls the finances, frequently controlling them too much, in the opinion of the employees as expressed on pay-days. The Head Office also includes a large clerical staff, the third general division being the Commercial or Sales Staff. Here we have arrived at a group that is recognized as Commercial, or primarily interested in sales. Such a staff usually includes engineers who have specialized on certain subjects such as Transformers, Switchboards, Induction Motors, etc., etc. They are used to help the Agents in making sales, to help customers in their engineering work, and to advise the Executive Staff on various commercial and engineering matters. In case of disputes with customers which involve the factory, the Head Office staff is almost sure to become an arbitrator or referee, the Designing Engineers taking the factory side of the case and the Salesman taking the customer's side. When the matter is finally settled, the Head Office representative is fairly sure of severe criticism from the losing side and feels proud of his diplomacy if he does not also get it from the Management. To properly fill a position on the Head Office Sales Staff, a man must be well posted on both Sales and Engineering work, and must do both all the time. His connection with price, quality, shipment and service is therefore a combination of that of the factory and of the District Office Sales Staff and need not be separately detailed.

A Salesman in a District Office, if he desires to succeed in selling Switchboards, should have all the regular qualifications of Salesmen in general and should also be accurate and very thorough as regards details, which is a feature commonly supposed to be almost directly opposed to certain of the inherent qualifications of a Salesman. It is necessary for him to know the construction and advantages of his own line of apparatus, and he should know that of his competitors almost as well. He should know how to apply his apparatus to his customer's conditions. As many customers have only a general knowledge of switchboards, the Agent should be able to determine not only what the engineer thinks he wants but also what he really needs.

Having determined what is required for a specific case, or at least the complete conditions of service, the Agent must be able to pass on the information, by letter and sketches, to the Departments that prepare the quotation. On receipt of this, the Agent must be able to prepare a definite, accurate and attractive proposal for the customer. This involves the ability to use correct, concise English clearly expressed. You will often find that your

price is high, your shipment long and possibly your Company has been falling down a little on service. In such a case, your only chance for a sale is on the basis of quality, and you can easily lose this chance if you cannot present a good clear cut statement. Therefore, I wish to emphasize the importance of knowing how to use the English language correctly and effectively.

Salesmen can assist themselves and the commercial organization a great deal by forwarding definite and accurate information to the Head Office, concerning the competition met on any particular proposition. I have often received reports on switchboard quotations stating that our price was 10, 15 or 20 per cent. high, or even worse, only to find on careful investigation, that the low competitor had quoted on a comparatively poor arrangement of the switchboard, or an apparatus of too small capacity for the conditions, or had entirely omitted certain valuable portions of the equipment. Under such conditions, a straight price comparison is both unfair and useless, and salesmen must be careful to get actual facts if they wish to avoid the unnecessary loss of business.

A service that every salesman should give his customers and one which they greatly appreciate, is in the elimination of operating troubles, and the adjustment of complaints. To do this properly you must know the apparatus well, and must know how it should be used. The first thing to do is to assume that the apparatus as furnished is O.K. and that the local conditions are to blame for the trouble. A thorough investigation along these lines will usually identify the cause of the trouble, and if it does not, you will at least then be able to make a clear and complete report on the subject, which will enable the Engineering Department from their records and knowledge of the apparatus, to determine and correct it. The final adjustment of complaints, if fair to both parties, can only be made after a thorough investigation.

Before leaving the subject of complaints, I wish to point out that many of them may appear trivial to the Salesman, partly because of their nature and partly because he knows that the particular trouble involved occurs very seldom. However, even small troubles look big to the operating Engineer, because they are a source of discussion and worry until they are fixed. Therefore, it is most important to give the best possible service and satisfy the customer on every complaint.

There is only one other point of importance that I wish to bring out here, which is that the Salesman is the Company's only direct point of contact with customers, and they base their opinion of the Company very largely on the individuals with whom they come in direct touch. They will often overlook faults on the part of the Company, if sure that the Agent handling the matter

for them is doing the best he can to protect their interests. Therefore, be sure that you are as good as your Company and its apparatus, and preferably a little better. You will find that the good personal relations resulting are an important asset.

THE SODA INDUSTRY *

By G. Norwood Comley,
Manager of the Canadian Brunner Mond Co. Amherstburg, Ont.

IT is not generally appreciated that the soda manufacture is a key industry to almost as great an extent as iron. In 1910 the iron production in the United States was 26 million tons, while soda ash was about one million tons, or one ton of soda ash for every 26 tons of iron. Even this comparison does not give a clear idea of the extent to which soda ash enters the many things which we are using daily.

It plays an important part in the manufacture of glass, paper, soap, food and medicines, water purification, textiles (washing and mercerizing), tanning, bleaching, cleansing (from laundry to metals), dyes, batteries, wood pulp, picric and carbolic acid, explosives, etc.

During the war the soda manufacturers throughout the world were supplied by Governments with men and coal without restrictions. Enlisted men, when found to be experienced soda manufacturers, were returned to their work under Government order. An interesting evidence of the importance of the soda industry to the war was shown at the Dombasle plant in France, near the border line of France and Germany. The line of battle approached to within five or six miles of this plant. The Germans tried hard to get possession of the plant, but made practically no attempt at destroying it, evidently with the hope of getting possession of it, until July, 1918. It was evident at this time to the Germans, as well as the Allies, that the German cause was hopeless. A bombardment of the plant was started, and in 48 hours they fired 500 shells into the plant. Fortunately, comparatively few of them struck and no great damage was done.

The United States uses about 20 lbs. of soda per capita per year, while Canada up to the present time uses about half that amount. Foreign countries, I believe, use a still greater amount.

Until 1880 the entire consumption of the United States and Canada was imported. At that time the Pennsylvania Salt Co. manufactured a small amount. In 1884 the Solvay Process Company was inaugurated, using the Ammonia Process, and from that time the imports to the United States rapidly decreased until

*Address delivered to the Chemical Club in November, 1920.

1905, when the imports ceased, and a small amount was exported. In Canada the entire consumption was imported from England and the United States until September, 1919, when the Brunner, Mond, Canada, Limited, Plant was started at Amherstburg.

History—The real history of the soda ash industry starts about 1775. Previous to that time nearly all the soda ash of the world was obtained either from natural deposits of sesqui carbonate of soda, which is converted to soda ash by calcining, or from the ashes of sea plants. At about this time, however, the demand exceeded the supply, and the French Academy of Science offered a reward for the development of a process for the manufacture of soda from common salt. Among other contestants was Nicholas Leblanc, whose process seemed encouraging and to whom a patent was granted in 1791. He at once started manufacture on a large scale, but during the French Revolution his plant was seized, his patent declared public property without payment of indemnity to him. He was so discouraged by this loss that he committed suicide. His process has been retained to the present day with only minor changes.

The ammonia soda process reactions were discovered in 1838 by Dyar & Hemming, but no one could work it out commercially until 1863, when Ernest Solvay and his brother, Alfred, developed apparatus which would successfully operate on a commercial scale. The first plant was built at Couillet, Belgium, and from that time on the industry made enormous strides. When Mr. Solvay took out a patent and proceeded to manufacture soda ash, it is said he believed himself to be the discoverer of the reaction of the process. Had he known of the many experiments made since Dyar & Hemming's discovery in 1838, all of which proved failures, he would not have had the courage to undertake the task. His ignorance was therefore a great boon to the human race, as he attacked the problem with great energy, combined with a high degree of mechanical skill. Even then his finances almost gave out before the results were accomplished. He made many improvements in the first few years, and in 1873 he built a plant near Nancy, France, which was very successful, and since that time the process has rapidly overhauled the Leblanc process until now the latter is doomed to extinction. The only feature which has enabled it to compete with the soda ash process is the production of hydrochloric acid as a by-product, and with the development of new methods for this production the complete failure of this process is bound to ensue.

The Solvay Brothers inaugurated a broad-minded policy whereby the rights to manufacture were granted to independent organizations in each of the countries whose demands warranted a home supply. Each of these companies is entirely separate and under its own control, but there is a system of interchange by

which all plants derive benefits from any new developments or improvements made in any of them. In this way the Canadian plant at Amherstburg has been developed, as an offshoot of the English firm of Brunner, Mond & Co., which has plants at Northwich, Middlewich, Sandbach and Lostock. At first there were few users of the ammonia process outside of the Solvay Companies, but there are now many in the United States and Europe. There are many countries throughout the world which are now starting up soda ash plants which have imported their entire product heretofore. China and Japan are both noticeable in this regard. It is rather interesting to know that in Japan in the majority of the plants started—there are about twenty which have been founded since 1918—there are only three which use the ammonia soda process.

Natural Soda—There are natural deposits of soda in a great many places throughout the world, some as nitrates, some sulphates and a very few in quite pure sodium carbonate and bicarbonate. Many of these deposits have tempted investors and a number are being exploited at present. It is generally found, however, that deposits are very far from railroads and points of consumption, and that impurities are hard to separate. The industry in this line therefore has not made rapid progress.

The Leblanc Process—Briefly the process is carried out as follows: Sodium chloride is treated with sulphuric acid, forming sodium sulphate or "salt cake" and hydrochloric acid. The salt cake is charged into a long reverberatory furnace, together with powdered coal and washed lime-stone or chalk, and heated to a temperature of about 1000° C. When the mass stiffens and the salt cake is all decomposed, forming soda ash, calcium sulphide and carbon dioxide, it is raked into a ball and washed with water in a series of tanks having perforated bottoms. The soda ash solution is heavy and settles in the bottom and is drawn off. This lye is settled and pumped to carbonating towers to convert any caustic soda present to carbonate. The liquor is then evaporated to dryness, the resulting product being monohydrate which in turn is calcined to remove the combined water.

The Ammonia Process—The reaction of the ammonia process may be expressed by the following formula:

$$NaCl + NH_3 + CO_2 + H_2O = NaHCO_3 + NH_4Cl$$

(simplest form)

The elementary process is a simple and continuous one. The ammonia gas is pumped through fresh saturated brine in the absorber. This heats up the brine and throws out impurities which are either filtered or settled out, unless the brine has been purified with lime and soda before ammoniating.

The ammoniated brine is then cooled and sent to the precipitator, where CO_2 is pumped through it. As the liquor comes down through the precipitator , first ammonium carbonate, then

ammonium bicarbonate is formed. In the lower part of the precipitator are cooling coils which chill the liquor and throw out the bicarbonate of soda. This is then filtered off, and the bicarbonate dried and decomposed to sodium carbonate or soda ash. The filtered ammonium chloride goes to the distiller where, after mixture with lime, the ammomia is to the distiller where, cooled mixture with lime, the ammonia is distilled off, cooled and goes to fresh brine again in the absorber, thus completing the cycle.

Raw Materials.—Raw materials used are, of course, salt and limestons with ammonia. Coal and coke are necessary adjuncts. Salt and limestone are generally found in the same neighborhood, salt ranging anywhere from 500 to 1,500 ft. below the ground level, and stone from surface to 30 ft. down. The salt strata are from 50 to 300 ft. in depth, and salt is either obtained from mining or by means of wells drilled to the bottom of the salt strata, water being sent down to dissolve the salt. Any of the several methods of deep well drilling may be used for raising the brine—deep-well pump, or pumping water down under pressure to force the brine up, natural water pressure, or air lift system. Frequenlty in the salt strata are found shelves of rock from 3 to 6 ft. in depth. It is unfortunate when these shelves are found, as they are apt to break away after the salt is dissolved under them and damage the tubes so it is necessary to redrill the well. This may take a week or months, and a fresh cave-in may start, almost immediately after completion of the cleaning-out of the well.

Chemical Analysis of brine obtained varies in different localities, calcium sulphate or chloride and magnesium sulphate or chloride being the main impurities. As stated above, these impurities are thrown out, either by brine purification or in the process of ammoniation, and are therefore not particularly serious. The brine of course must be as nearly saturated as possible.

The purity of the limestone is quite important. Calcium sulphate, magnesium sulphate and silica are the main impurities. The silica forms clinker in the kiln, the magnesium uses up the fuel, and the sulphate causes trouble all along the line. Stone with 97 to 98 per cent. carbonate is always sought for the process.

Apparatus—Taking the apparatus in detail we have first the absorber. It consists of a tank with compartments containing umbrella-shaped distributors for the upgoing gas and overflows for the down-going liquor. If the brine has been purified beforehand, the absorber keeps clean—if not the impurities are thrown out in the absorber, and an interesting game develops. It is, of course, understood that in all cases where substances are thrown out of solution, scaling takes place, and therefore the absorber rapidly becomes fouled with scale of calcium and magnesium carbonate. The calcium comes out of solution easily and permanently, but the magnesium precipitates out and returns to solution

so easily with various amounts of ammonia and temperatures that it is a nice trick to see that it send up as a precipitate, and so is removed in the filter or settler. If it goes on in solution from the absorber it gradually comes out, scales pipes and increases impurities in soda ash. It is necessary to provide spare apparatus in order to cut out the scaled apparatus at frequent intervals for cleaning.

Precipitator—Precipitator is also a high tank with umbrella-like distributors for the upgoing gas, but, unlike the absorber, it contains a solid mass of liquor. In the lower portion of the precipitator are cooling tubes for cooling the liquor to the proper degree for precipitation. The ammoniated brine enters near the top, coming down through the precipitator, and is drawn off the bottom with entrained bicarbonate of soda. CO2 gas from the lime kiln and from the decomposed bicarbonate is pumped into the bottom, and the remaining gas (after practically all the CO2 has been absorbed) is drawn off the top and washed with brine. A large amount of heat is evolved during the absorption of CO2, which must be removed. In the early stages of the industry this was done by flushing water over the outside of the precipitator, which was, of course, an uneconomical and inefficient method. They are now cooled as mentioned above.

From thermo chemical and other known data we find we have to deal in precipitation with a reversible action. It is therefore natural to conclude that a low temperature favoring the more complete precipitation of NaHC03, and thus carrying reaction in the direction in which we wish it to go, is most desirable. However, if too low a temperature is obtained, there is danger of separating out excessive quantities of the other three salts in solution. viz., salt, ammonium chloride, ammonium bicarbonate. Reaction therefore is stopped considerably before the decomposition of all salt, which is in effect taking advantage of the law of mass action. About 25 to 33 per cent. of the salt in the brine is therefore lost.

The three things to be desired in the precipitation process are maximum NaCl convertion, minimum precipitation of other salts in solution and a coarse grain bicarbonate which is readily filtered and washed. Here as in the other apparatus where any precipitation takes place, scale is formed which gives a considerable amount of trouble. It is, therefore, necessary to have spare apparatus in order that each precipitator may shut down in its turn and scale removed.

The mother liquor containing sodium bicarbonate in suspension is discharged from the bottom of the precipitator and flows to the vacuum filters. From the filters the wet bicarbonate is conveyed to the dryers. These are either of the oscillating or rotary type. The usual form in this country is the horizontal rotary type, similar to the cement furnace. Reaction taking place

in the dryer is represented by the formulae:

$$2\ NaHCO_3 + \text{heat} = Na_2CO_3 + CO_2 + H_2O$$

$$NH_4HCO_3 + \text{heat} = NH_3 + H_2O + CO_2$$

The gas given off from the dryer should contain over 70 per cent. of CO_2, and after being washed to remove the ammonia is used over again (with the addition of gas from the kiln) in the precipitator.

Bicarbonate.—If bicarbonate of soda used for baking powders, baking sodas, etc., is desired, the wet crude bicarbonate is taken from the filters, dissolved, and recarbonated in the precipitator, the pure bicarbonate resulting. It has not been found possible to dry the crude bicarbonate sufficiently to remove the ammonia without decomposing it.

Caustic—If caustic soda or sodium hydrate is desired, any of several processes are used—by lime process in which the finished soda is dissolved, causticized with lime and evaporated in the various forms of evaporators and pots; or the Loewig process in which dried soda is heated with feric oxide, forming sodium ferite, which is then lixiviated and sodium hydrate and ferric oxide resulting. The finished caustic is then either packed directly in drums, forming solid caustic, or flaked by means of the flaking machines on the market, if flake caustic is desired. These flaking machines consist of plain cast iron drums, which are cooled and upon which the hot concentrated caustic is poured. The caustic is cooled and hardened on the drums, and flakes off into small chips, which are packed direct. In this process the removal of impurities and the doping of the finished caustic for color are the most interesting features.

Ammonia Recovery—The mother liquor from the filters containing some free ammonia and some fixed, i.e., ammonium chloride, is sent to the distiller, where it is treated with milk of lime, for decomposition of ammonium chloride, and the free ammonia distilled off by means of exhaust steam from various engines of the plant. At this point is added the crude ammonia to replace the wastage in the operation.

$$2NH_4Cl + CaO + \text{heat} = 2NH_3 + CaCl_2 + H_2O$$

The distiller consists of a tall tank similar to the absorber with umbrella-like distributors for the uprising steam and gas. The resultant liquor is calcium chloride and salt, most of which goes to waste. A small portion of it is evaporated for recovery of the salt and solid calcium chloride, the latter being used for refrigerating purposes, road manufacture, etc. The distiller, like the absorber, also scales up, due to precipitation of calcium and magnesium sulphates, and therefore requires a spare for continuous performance. The scale formation makes a very interesting study throughout the process, and is continually producing surprises.

Very slight changes in strengths of liquor temperatures or pressures will increase or retard the rapidity with which the scale forms in a most surprising manner, and even after many years of experience there is still much to be learned in this line.

Lime Kiln—The lime kiln is the source of the C02 gas used in the precipitator, also the lime used for recovery of ammonia in the distiller. The requirements for proper burning of lime in the kiln are therefore: limestone, as rich as possible in order to have as little impurity going to the distiller and as little slag formed in the kiln as possible. The kiln must have a tight top in order to obtain as rich C02 gas as possible. In this connection coke is used in order to provide rich C02, and the coke should be properly sized and as free from ash as possible. The operation must be conducted with care with just a sufficient amount of air to completely burn the coke and a sufficient amount of coke used to completely burn the limestone without overburning it. For the proper recuperation of heat the kiln should be high enough to warm the air up before reaching the fire zone and to cool the gas off at the top before leaving. The gas leaving the top is washed in order to further cool it and remove the dust.

Lime Slacker—The burned lime is slacked in either stationary tanks with agitator or in horizontal rotary tanks. The milk of lime, of course, is kept at as strong a consistency as will flow freely in order to keep down the amount of water which must be boiled up in the distiller.

Continuous Ammonia Cycle—As the ammonia in the process makes a complete cycle from the absorber to the precipitator, to the distributor and back to the absorber again in a fixed time, and repeats that cycle without pause, it is absolutely necessary that uniform and steady operation should be obtained. The brine enters the process at a fixed rate and passes through the system and out through the distillation exit at a steady rate if there are no interferences. If there are no interferences it is therefore easy to plan on steady strengths of brine and ammonia, temperatures, pressures, etc. It requires long experience, but it can be done if there are no interferences; and every manufacturer will tell you the secret of efficiency in the manufacture is a steady, continuous and uniform flow of material from raw to finished product.

Raw materials must be started in a proper quantity and flow through the proper channels to join each other at fixed points to be moulded into the finished product. In many industries the flow can be stopped at night and started in the morning without loss. The flow can be arranged by machinery with exact precision. In a visit to such a plant you can see one piece of metal swing into place by an automatic arm just after the previous tool leaves by means of another automatic arm. The whole process is mechanically timed and operated with no variables.

In a chemical manufacture the conditions are totally different. Pipes and apparatus scale up and solid matter settles out, thus changing velocities, pressures, cubical contents, surface areas, etc. These are anticipated when possible. But there are frequent conditions which cannot be foreseen. An old foreman used to say if we could see through cast iron we would be all right. An apparatus will frequently run along with no apparent change in conditions when of a sudden everything stops at once. Upon shutting down for examination the interior will be found in such a state of fouling that it is difficult to imagine how it had run at all for the past week or more. These conditions continually keep the business interesting by turning up at unexpected moments in unexpected places.

Electrolyptic Caustic—The direct production of caustic soda from salt brine by means of electric cells is a very rapidly increasing industry. Salt brine is run through the cell, $NaCl$ decomposed and caustic hydroxide formed at the positive pole and chlorine given off at the negative pole. The chlorine gas is then run over lime to form bleaching powder.

Various Forms of Soda—There are many forms of soda used on the market, the simplest form, of course, being soda ash or sodium carbonate. This is used chiefly in the manufacture of soap and paper, the various soda salts, silicates, acitates, permanganates, chromates, prussiates, hypochorites, etc., enamel, water purification, tanning, etc. In the manufacture of glass, although soda ash direct can be used, it is preferable to use what is ordinary known as dense ash. This is straight soda ash densified so that the weight is about 75 per cent. greater per cubic ft. than ordinary ash.

Bicarbonate of soda used in baking powders, baking soda, etc., caustic soda used in soaps, paper, batteries, electroplating, mercerizing, viscose, dyes , salicylic acid (aspirin), oxalic acid and acids used in explosives—picric and carbolic.

The modified sodas are in many forms—soda crystals, sal sodas, mixtures of soda ash and bicarb with and without the addition of water are used in the various forms for washing, water softening, metal cleaning and woollen mills. Combination of caustic soda and soda ash generally known as causticized ash is used where a stronger alkali is desired for cleaning metals, washing bottles, etc.

By-products of Soda Ash Industry.—Calcium chloride is produced from the discharge liquor from the distillation and is used in connection with road building, drying, refrigerating, steel tempering, coal washing, etc., also in the manufacture of crown filler. Ordinary salt (also made from the discharge from the distillatiion in connection with calcium chloride) which of course is used for ordinary salt purposes, tanning, refrigerating, water purification, etc. Calcium carbonate in very fine form is

obtained from the lime caustic process and is used as precipitated chalk, paper filler, paint and rubber fillers, tooth powder, etc.

Ammonium Chloride is sometimes made from liquor, leaving the precipitating column by excessive chilling.

Outlook for Soda Industry—Conclusion.—The consumption of soda in its various forms has fluctuated less in the past than the majority of commercial products, and there is every reason to believe that as time goes on it will be found that there is more and more constant and steady demand for the product. The consumption per capita has increased slightly more rapidly than the population in both U. S. and Canada, and it is believed that in Canada the increase is more rapid than in the States. The increasing of consumption per capita is largely a matter of education, both regarding the individual uses and manufacturing uses.

In the latter case one of the most noticeable chances for education is along the lines of metal cleaning. A few years ago comparatively no soda was used in this way, an dit was a very difficult proposition to clean metals in various manufactures as was really needed. The various shops are now very rapidly learning of the value of soda in this use, and are very greatly benefited thereby. The use in bottle washing and laundries is also very rapidly increasing.

NEW BUILDING FOR ELECTRICAL ENGINEERING AND APPLIED MECHANICS

SOME years ago, the Board of Governors of the University prepared an elaborate plan of possible future building extensions on University property between College and Bloor streets. Among these was a rectangular group of buildings for Applied Science, of which the Chemistry and Mining Building on College street was the south side, and the Thermodynamics Building the north side. The new building is the easterly side of this group.

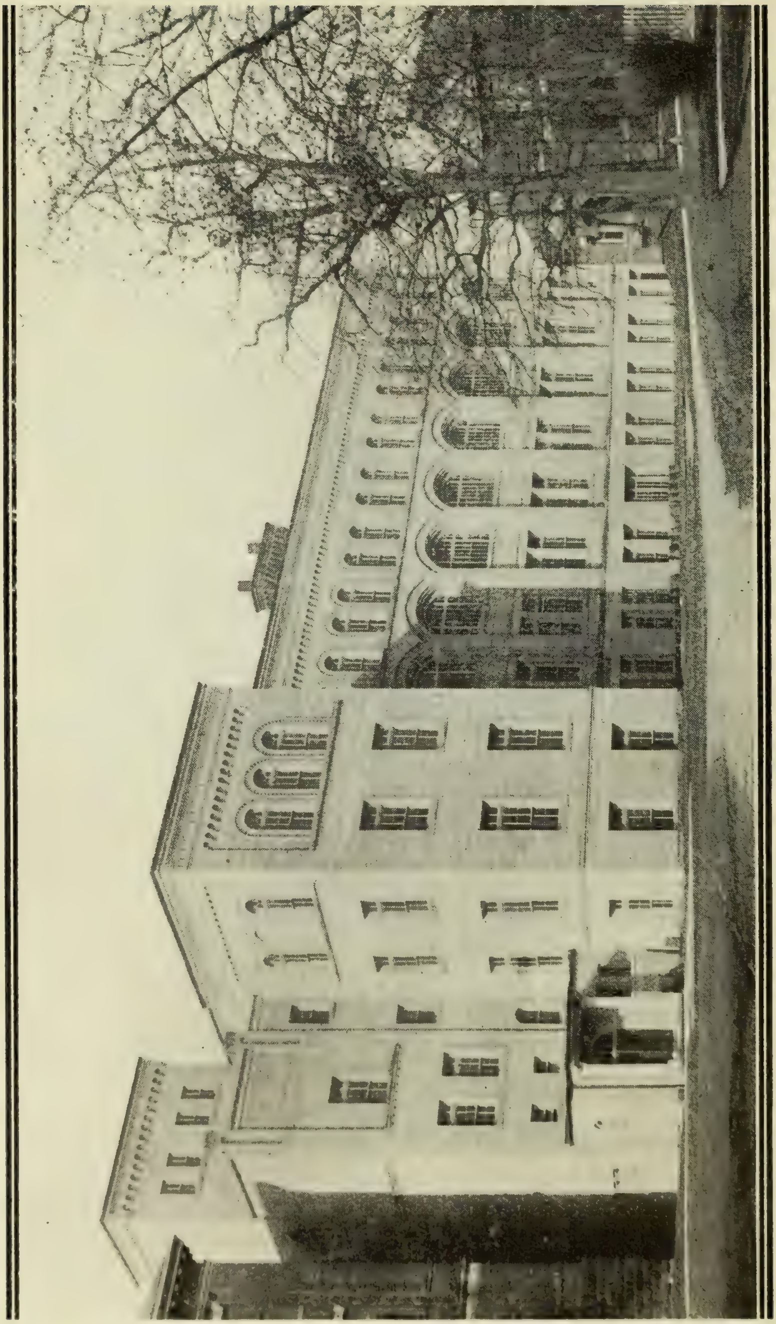
Construction was approved by the Board of Governors in February, 1919, when an appropriation of $350,000 was made available for this purpose by the Ontario Government. Messrs. Darling and Pearson were engaged to prepare plans, and work was begun on the excavation work later. Construction has proceeded more or less continuously since then, with the result that the building was sufficiently advanced to permit partial occupation in September, 1920.

The building, roughly 220 ft. by 65 ft., is constructed of buff brick trimmed with sandstone, the front facing east. Throughout the entire length of each of the four floors a north-and-south corridor extends. Laboratories, lecture rooms, etc., are located on each side of the corridors. Floors are of reinforced concrete of the beam and slab type, arranged on the unit system. Nine-inch brick partitions, separating adjacent rooms, are built over the beams where required. This feature permits any large room to be sub-divided, if necessity occurs, into any lengths which are a multiple of 15 feet, 6 inches, the centre to centre distance of the girders. If two adjacent rooms are to be united, a removable brick partition can easily be taken down. There are three lecture rooms, two of which will seat about 120 students each, and one about 60 students. A library is nicely fitted for the joint accommodation of both departments. Reading comfort at tables is provided for 30 men.

Heat and electricity for light and power are provided from the University central plant. Good illumination and ventilation have been made features of the design. An elevator of three tons' capacity serves for moving apparatus to any floor in the building.

Department of Applied Mechanics.

The main strength of materials' laboratory measures 126 ft. by 26 ft., and is located in the basement. In it have been installed the various testing machines formerly housed in the Engineering Building, viz., three Riehle machines of 200,000 lb., 100,000 lb., 20,000 lb. capacity respectively, the Olsen Torsion machine, the 30,000 lb. Buckton, the 30,000 lb. Olsen wire tester,



the 30,000 lb. Olsen column testing machine, the 5,000 lb. Riehle cross-bending machine, the Emery, and the Brinell hardness testing machine. These have been arranged roughly in two rows along the longer walls, and provision has been made in the lay-out for adding to their number as necessity may require and as funds warrant. To accommodate the large 200,000 lb. machine, a well was provided in the floor above, and into this the upper part of this machine extends. A travelling crane is to be erected which will serve every part of the machine, thus facilitating the handling of parts and testing equipment and the making of repairs. For this, the main I-beams are already in place. The well is floored over at a height of about seven feet above the floor of the lecture room immediately above, and over it the tiers of elevated seats in the lecture room have been placed. Because of this, no floor space has been sacrificed.

For the accommodation of a large capacity testing machine, the purchase of which is contemplated in the future, another well has been provided in the floor above the main testing laboratory. This well is, however, now floored over, and the space above employed for storage until such time as the new machine is installed.

The asphalt laboratory, 30 ft. by 25 ft., is equipped with all appliances necessary for conducting tests on all classes of bituminous materials. For the examination of road metals a full equipment consisting of Deval, cementation and toughness machines, has been provided.

A laboratory for cement testing, 30 ft. by 26 ft., another for experiments on the creosoting of wood, another for concrete mixing, another for small capacity testing machines, study rooms, etc., complete the facilities for work in strength of materials. The equipment is not yet all in place, but it is expected that by the opening of the Autumn term, 1921, the entire plant will be ready for use.

Department of Electrical Engineering.

This department occupies approximately two-thirds of the working space in the building.

The two large lecture rooms referred to above are provided with all kinds of electrical services necessary for lecture demonstrations. Between these rooms is a room for storing apparatus, equally convenient for each lecture room.

The power service for the laboratories is three-wire direct current, 230-115 volts, 500 amperes capacity. Motor-generator sets provide alternating services, 60 k.v.a., 110 volts, 3 phase, 60 cycles, and 30 k.v.a., 110 volts, 3 phase, 25 cycles. The somewhat variable voltage of the direct current supply will be regulated by a booster set controlled by automatic regulators. The 60 and 25 cycle services will also be regulated automatically

as to voltage and frequency. A moderate amount of storage battery capacity will also be available.

The laboratories are as follows: An alternating current machine laboratory, 106 by 26 ft., containing switchboard, service sets, local panels, various kinds of alternators, motors, converters, transformers, etc., for experimental work, with an adjoining calibration room for alternating-current instruments. A direct-current machine laboratory containing switchboard, local panels, a variety of testing sets, with adjoining calibration room for direct-current meters. An instrument laboratory, 106 by 26 ft., with switchboard and local panels, specially fitted for a large variety of electrical measurements, and an adjoining storage battery room. A radio laboratory fitted for experimental work on various phases of communication problems. Three laboratories specially fitted for study of conducting, magnetic, and dielectric materials. Four laboratories are reserved for research problems. Other rooms are fitted for special kinds of experimental studies, for electrical design, as study rooms, etc. A constant temperature standards room is located in the basement.

The three main switchboards on three floors in the building are stacked vertically to simplify the conduit work. Circuit-breakers are used almost entirely for protection instead of fuses. Each laboratory has suitable local panels for conveniently making experimental connections. Spare circuits are arranged so that any necessary connections between laboratories on any floors can easily be made.

On the roof will be erected a three-conductor aerial between masts 140 ft. apart. A single-conductor aerial 1,200 ft. long will be stretched in one span from the north mast to the tower of the Main Building on the north side of the campus.

THE TESTING AND RESEARCH LABORATORIES OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.

By W. P. Dobson, *Laboratory Engineer.*

THE Testing and Research Department of the Hydro-Electric Power Commission was organized to supply a service which was felt to be necessary as soon as the Commission began operating its transmission system. The Commission was a large purchaser of engineering materials and apparatus, and the intelligent selection of such material and apparatus required comparative tests and thus a testing laboratory. The problems of high tension transmission necessitated continuous attention, and thus facilities for investigating electrical phenomena of high tension lines became necessary. Since a great deal of the purchasing of

An address delivered before the Electro Mechanical Club in January, 1921.

supplies by municipalities on the system is centralized in the Purchasing Department of the Commission, the testing facilities were thus of value to those municipalities. From a small beginning the department has evolved into a testing and research bureau, its functions having gradually expanded by the centralization as far as practicable of testing, research and experimental development work under the direction of this department.

Functions.

The functions of the department are testing (including inspection) and research. In the discharge of these functions the laboratories act upon instructions received from other departments regarding specific tests, or research problems, or upon instructions respecting the undertaking of general investigations. The department may also suggest investigations and proceed with them upon receipt of approval of the suggestions.

The testing work falls into two broad groups: routine and special.

Routine testing, as the name implies, is the application of standard methods of testing to particular cases. These methods apply to many classes of engineering materials and apparatus and are usually embodied in specifications issued by engineering and testing societies. Methods have also been developed in our laboratories as a result of experience in testing.

Routine testing may be further subdivided, depending upon the purpose in view. If it is desired to select from a number of samples submitted for purchase, that most suitable, *acceptance tests* are made. Such tests are carried out in accordance with standard methods on such materials as incandescent lamps, cement, rubber gloves, etc. It is also necessary to ascertain the quality of a material after it has been placed in service. For this purpose *control tests* are made periodically on such material as transformer oil, linemen's rubber gloves, etc. A third type of routine testing consists in *standardization and calibration*, chiefly of electrical measuring instruments, the purpose being to maintain the accuracy of the laboratory instruments used in test and research work, and also of the portable standards of the meter inspectors which are used to check meters upon customers.

Special tests are those for which no standard methods have been adopted, and apply chiefly to material or apparatus of a new kind or type. In such cases, the general methods and rules of testing are used in so far as they apply, and it is usuaaly possible to obtain comparative results as between several samples submitted. Continued experience in testing the same product results finally in standard methods and in the transition from special to routine testing.

The testing work which the department has been called upon to perform has covered almost the entire range of engineering

materials and apparatus. The largest volume has been heretofore electrical, but with the expansion of the Commission, problems in structural, physical and chemical testing are rapidly increasing.

Closely connected with testing is the inspection of engineering material. This is largely carried on by this department for the engineering department of the Commission.

The second main function of the laboratories is research. This is so closely allied with testing that the dividing line is difficult to distinguish. Many testing problems require investigatons which are of a somewhat general nature, and are properly classifiable as research. In the course of testing work many problems are also suggested, which give rise to research. The chief sources of research work are the engineering and operating departments of the Commission. The subjects proposed deal directly with problems in the design, construction or operation of the system. They have been heretofore largely electrical, but, as with the testing work, the range has been extended to structural and physical problems. The object of all the research work undertaken is as stated above, the solution of particular problems. No researches in pure science are undertaken, nor in any general subject unless it is evident that the results may have an immediate application to the problems of the Commission. It is, of course, to be expected that in the investigation of a particular problem, the solution of some general problem may become necessary. This may be undertaken if no solution exists, but such cases are rare. It is the writer's opinion that the investigation of general problems such as, the theory of electrical apparatus, the properties of materials, etc., is the field of the Engineering Research Schools, and that this work can be carried on conjointly with the training of men for research work.

The research work is of three types:—

(1) Theoretical.

(2) Experimental.

(3) Compilation of data.

The theoretical work consists usually in the application of mathematical analysis to specific electrical problems such as solution of high tension networks, stability and parallel operation of generators, etc. This is often carried on in conjunction with experimental investigations which form the principal portion of the research work. The preparation of general reports on various subjects at the request of other departments necessitates the compilation of data and search of engineering literature, and is thus classed as research.

All research work is carried on by co-operation among the various research men on the laboratories' staff and in other departments interested. One man is made responsible for the con-

duct of any investigation and the preparation of the final report of his findings. He is assisted when necessary by other members of the staff by conference or in subdividing the work. Periodical conferences are held at which particular problems and general questions are discussed.

Organization and Equipment.

The work of the department is subdivided among several sections, as has been found most convenient in facilitating the routine work. These sections work in co-operation in this work and in the conduct of research work as has been indicated.

The equipment includes sources of power for all kinds of electrical testing, means of controlling and adjusting the same, electric circuits connecting all parts of the laboratories, standards of electrical measurement, high voltage transformers, mechanical and structural testing machines and chemical apparatus. A machine shop specially designed for delicate precision work, and a photographic section completely equipped, have also been provided.

High Tension and General Testing Laboratory.

This section is responsible for all electrical tests except those connected with standardization, calibration and photometry. Tests on transformers, motors, generators, insulators and insulating materials are regularly made in the laboratory and in the field. The routine testing of transformer oil is an important operation which is carried on continuously. Monthly samples of oil from each 110,000 volt transformer and oil circuit breaker are sent to the laboratory and tested for dielectric strength, presence of moisture and sludging. A continuous record is thus kept of the condition of the oil in the transformers and circuit breakers, and dangerous conditions in these most important links of the system can be quickly remedied with this information at hand. The periodic testing of linemen's rubber gloves is also an important routine test. These gloves are purchased under strict specifications and stored in the laboratories. Before being sent out each pair is given a dielectric test of 10,000 volts and sealed in a the laboratories for re-test. Every glove which punctures on a 10,000 volt test or shows excessive leakage, is discarded. The laboratories work in co-operation with the Accident Prevention Department in this work.

Many tests have been made for the Engineering Department on large generators after installation. These acceptance tests are in some cases quite elaborate, including oscillographic records of short circuits besides temperature, efficiency, dielectric tests, etc.

The research work carried on by this section is of a varied nature, ranging from simple problems on the border line between

testing and research, to extensive investigations involving considerable analytical and experimental work. The following list of subjects which have been attacked or are receiving attention, though not complete, will illustrate the nature and variety of this work.

High tension insulators: A continuous investigation including methods of detecting defective insulators, causes of insulator failure, investigation of new types, etc.

Properties of iron wire as transmission line conductors.

High voltage measurement. The development of an accurate method of measuring voltage up to 300,000. A meter depending on the formation of corona for its indications has been constructed in the laboratory. Tests on this instrument indicate that it will give results of much higher accuracy than are obtainable by any other method.

The forces on busbars under short circuit conditions (theoretical and experimental). This has an important application in the design of busbars and the location of bus supports in large power stations where the generator capacity is sufficient to produce extremely heavy currents under short circuit.

High tension line calculations. Regulation, division of current among various sections of a high tension network.

High tension fuses. Short circuit tests on existing types to determine their limitations.

Compilation of data on inductive interference between power and communication lines. A report was prepared treating the theoretical, practical and legal aspects of this question.

Considerable work has been done in making tests on materials preliminary to the preparation of specifications, and in working out methods which will be of value in the routine testing.

Approval Laboratory

In this section is carried on the testing and inspection of electrical material, devices and fittings submitted for approval in accordance with the Electrical Inspection Act, which requires that all material, devises and fittings be approved by the Commission before being sold or used in Ontario. The object of this regulation is to eliminate fire and accident hazard from electrical apparatus and appliances, and thus protect the public from dangers incident to the use of electricity by reason of defective construction. This work is similar to that carried on in the United States by the Underwriters' Laboratories.

A routine procedure has been adopted under which manufacturers submit samples of their product to the Laboratories, where they are examined and tested in accordance with standardized methods as set forth in specifications for the testing and construction of electrical appliances. When a device has been found to agree with the specifications, it is formally approved

by the Commission and may be marked by the manufacturer. The Commission issues a list of approved devices and conducts an inspection service in order to be assured that approved devices are kept continuously up to standard by the manufacturers. Under this inspection service the Laboratory inspector visits the factories and examines samples taken from stock. Samples of approved devices are also purchased on the open market and examined in the laboratories.

The following partial list of devices examined and tested in the Approval Laboratory will indicate the nature of this work:

> Electrical irons, toasters, grills, air heaters, water heaters, washing machines, switches of all kinds, plug and cartridge fuses, wire and cable, motor-starting switches, ranges, fans, vibrators and massage machines, conduit, fixtures and fixture fittings, electric signs, insulating materials, farm lighting plants, etc.

This work is carried on in co-operation with the Electrical Inspection Department of the Commission, the various electrical contracting, manufacturing and jobbing associations in Ontario, and the Fire Underwriters.

Meter and Standard Laboratory

This section conducts tests on measuring instruments and has charge of the electrical standards of the Commission. These standards consist of precision resistance, potentiometers and standard cells, which have been checked against the standards maintained by the United States Bureau of Standards at Washington. They are used to maintain the accuracy of the laboratory meters and of the meter inspectors' portable standards against which are checked the meters installed on customers' loads.

All laboratory test meters are in the custody of the meter laboratory whose duty it is to keep them in good condition. To this end a schedule has been adopted providing for periodic calibration and examination.

New types of meters appearing on the market are investigated by the meter laboratory. Considerable attention has been given to the subject of demand measurement and an extensive investigation of the performance of various types of demand meters was recently completed. The results of this work have been published. The section also co-operates with other sections in all matters relating to electrical measurement.

A considerable amount of repair work on meters is done at the request of the municipalities on the system, chiefly on watt-hour meters. A small machine shop is used for this purpose and also for the construction of special types of testing equipment for the laboratories.

The equipment includes, in addition to the standards already mentioned, a considerable number of portable meters for

laboratory and field test work, galvanometers of a variety of ranges and sensitivities, condensers, inductance coils, Wheatstone bridges, etc. An oscillograph is an important item of equipment. This has been provided with accessory equipment, so that it can be readily shipped, and it has on frequent occasions been set up in power houses and sub-stations on the system, for the purpose of investigating abnormal conditions.

Photometric Laboratory

The testing of electric lamps, lighting fixtures and illumination accessories of all kinds is carried on by this section. All lamps are purchased by the Commission under specifications which provide for rigid mechanical inspection and electrical tests. The mechanical inspection embraces such features as loose boxes, defective tips, and general care in assembly. The electrical tests consist in candle power and efficiency measurements, and life tests conducted at a constant voltage. Several standard bar photometers and an 84-inch integrating sphere photometer are used for the candle-power measurements. The life-testing equipment consists of an auto-transformer supplying by means of taps, voltages in one volt steps to a series of racks upon which the test lamps are mounted. Special means are used to keep the maximum voltage variation less than one per cent.

During the past year this section has tested many samples of automobile headlights for the Provincial Department of Highways in accordance with the requirements of the anti-glare law now in force in this Province. This law provides certain maximum and minimum candle-power values which all headlights must produce; and automobile owners must provide themselves with devices approved by the Department of Highways. This approval rests upon the test results obtained in the laboratory.

This section has also conducted extensive surveys of street illumination throughout the Province, and has designed several lighting installations of a special character. The most notable of these was the illumination of the Horseshoe Falls of Niagara on the occasion of the visit of the Prince of Wales in 1919.

Engineering Materials Laboratory

The work of this laboratory includes the testing and inspection of structural materials. Equipment is available for tension and compression tests up to 100,000 lbs and for compression tests up to 200,000 lbs. Routine tests on steel samples, beams, cable, line hardware and many other materials are regularly made. Many special tests have been made to determine the most suitable type of material for a given use. As an example, an extensive series of tests was recently made on a number of types of supporting insulators for the busbars in the Queenston generating station. These supports were given a 10,000 lb. canti-

lever test, this being the estimated force upon them (having regard to a proper factor of safety) under conditions of short circuit, which would cause a current flow of many thousands of amperes.

The testing of cement forms an important part of the routine testing. From each car of cement purchased by the Commission, a sample is taken at the mill by a laboratory representative, and shipped to the laboratory. It is there tested in accordance with the standard specifications of the Commission, and the results of the tests wired to the job upon which the car is to be used. The car is accepted or rejected as a result of the tests.

Inspection of such materials as structural steel, reinforcing steel, steel transmission towers, bridges, penstocks, and other steel materials entering into the construction of power houses and transmission lines, is carried on by this section. Inspectors are sent from the laboratories to the factories to inspect the fabrication, and to the field to inspect the erection of the structures. The inspection is intermittent on small jobs, but on jobs of sufficient size and importance to warrant the expense, the inspectors follow every step in the fabrication and erection.

It will be evident from the foregoing that all material used on the works of the Commission is purchased subject to inspection. This inspection is carried on by the laboratories when the location of the material and the size of the order warrant it, and in cases of small orders placed at a distance from Toronto, arrangements are made by the laboratories with local Inspection Companies to carry on the inspection. In either case, the laboratories are responsible for the supply of materials in accordance with the specifications.

The inspection of concrete materials is also the duty of this section. This work includes all the materials entering into concrete construction and is carried on in accordance with standard instructions followed by all departments concerned. The Engineering Department designs the structure and specifies the compressive strength required. The Laboratory is then instructed to find suitable supplies of sand and stone in the neighborhood of the projected work, if possible, and to make such tests upon these materials as will determine the proportioning to produce concrete of the required strength. During the progress of the job changes in the initial proportions may be necessary as a result of non-uniformity of the sand and stone. This is provided for by placing an inspector on the job, who makes daily tests on the sand and stone and sets the proportions as a result of these tests. In order to check the quality of the concrete placed, test samples are taken from the mixer. These are sent to the laboratory and tested for compression after 28 days, or are stored on the job and tested by a portable testing machine. The introduction of this method of inspection has been of benefit in the saving of cement,

as advantage can be taken, as the job progresses, of any non-uniformity in sand stone, a result not possible under the old method of fixed proportion. Its value to the designing engineer lies in the fact that he knows the strength of the structure. Without this knowledge he is forced to a more conservative design calling for higher strength in many cases than is necessary.

Considerable research work in concrete has been done by this section. The most extensive investigation has to do with methods of proportioning and is still in progress. Several publications have been issued by the Commission, giving the results of this work. Many tests have been made on concrete waterproofing and hardening preparations, quick-setting materials, and investigations of subjects connected with various features of concrete field work. A committee on concrete meets periodically and advises the various departments on all matters pertaining to the concrete work of the Commission.

Chemical Laboratory

This laboratory is under the control of the engineering materials section. It is equipped for a considerable variety of chemical testing, and tests regularly many classes of materials purchased under specification, and much material for which specifications are not available. Lubricating oil, gasoline, paint, rust proofing compounds, galvanized hardware, are among the routine products tested. Special tests have been made on water from parts of the system, to determine its suitability for drinking purposes, or for its action on steel and copper pipes, on fire extinguishing devices, and many other types of safety devices. The engineering, purchasing, operating and accident prevention departments have been the chief sources of this work.

The work of the laboratories as described above is confined chiefly to the needs of the Commission and its municipalities. On frequent occasions, however, advantage has been taken, by the public of the testing facilities provided. Commercial tests have been made on lamps, meters, motors and other electrical apparatus. These tests have been requested both by prospective purchasers of electrical goods who wished to obtain information as to the comparative values of samples submitted to them, and by electrical manufacturers not possessing special testing equipment, who desired to know the characteristics of apparatus which they were developing. No attempt is made to compete with private testing laboratories in this work, but the absence of commercial electrical testing laboratories in Ontario has resulted in a considerable use of the laboratories of the Commission by the public.

RESERVOIRS*

By William Gore, M.E.I.C.

THE building of reservoirs or fixed receptacles for the storage of water is a very ancient art. As soon as man began to collect in cities the need for an abundance of water as a prime necessity of life became pressing, and, while fresh-water lakes and rivers were sometimes available for the whole or part of the time, the occurrence of droughts, accompanied by the failure of crops and death by starvation, if not by thirst, made the storage of water in many cases a necessity of fixed habitation.

Unfortunately, the absence of this provision obtains in several parts of the world to-day, and death from starvation from this cause is not uncommon. The ancient Egyptians supplemented the seasonal inundations due to the spreading out of the River Nile by building reservoir dams across many of the lateral ravines or wadys which lead down to the Nile. Irrigation reservoirs are said to have been constructed in Beluchistan three to four thousand years ago, and similar works have been attributed to the ancient civilizations of Peru, India and Ceylon. In the Hebrew Scriptures references to pools and conduits appear and Noah must have had considerable skill and knowledge in the art of retaining water to have built the Ark. The art was practised under the Greeks and Romans, but, considering the high state of architecture under these people, it is a matter of astonishment that, outside a few aqueducts, very little remains to show that they understood how to retain water in large or deep reservoirs. With the exception of Portland cement and iron, the materials used by these ancient constructors were the same as those used to-day. Advantage was taken of some natural declivity, generally upon a catchment area, and the low parts dammed up by stone, compact earth and clay. Owing to water being a heavy, intrusive fluid, which, when moving, becomes highly erosive, coupled with the neglect of the necessary precautions or the difficulties in providing the proper outlet works and overflows, the failure of these early reservoirs was an almost foregone conclusion, and there are only one or two instances of ancient reservoirs remaining in use to-day.

Coming down to more recent times, the Spaniards built several large reservoirs on catchment areas for water supply and irrigation during the sixteenth century and later. Some of these are in use to-day. One very large one has failed and others have become choked with the detritus brought down by the rivers which feed them. The early Spanish reservoirs were formed by massive dams of masonry nearly as thick at the top as at the bottom, built across narrow gorges, forming horizontal arches, as

*An address delivered before the Civils Club in March, 1921.

well as retaining walls, which materially increased their stability.

Reservoir building has been carried on from the earliest times in India, and there is one instance of reservoirs being in use at the present time constructed 400 to 500 years ago. Some of the ancient Indian reservoirs—or tanks, as they are called,—covered many square miles. In the Madras Presidency alone there are said to be reservoir embankments collectively reaching 30,000 miles in length. The heights of these Indian embankments were generally limited to about 30 feet, but there is an instance of one 100 feet high, the embankment in this case being 400 feet thick at the top and 1,000 feet thick at the bottom.

The Indian embankments, after long experience, were generally safe and satisfactory, but difficulties with outlet works and insufficient provision for flood discharge has been the cause of many failures with frightful consequences. This has been particularly the case where the upper tank of a series on one river gave out, bringing the whole series to grief.

The present age is, however, essentially the age of reservoir building in all parts of the world. They exceed in magnitude anything that has gone before. The Gatun Reservoir, forming part of the Panama Canal, covers 164 square miles, and the Assuan Dam backs up the Nile for 180 miles. The depth of water retained has reached the height of the Royal Bank Building, in Toronto, walls of 300 feet in height have been constructed, and greater heights than these have been projected. The different forms of retaining walls and embankment are legion depending upon the nature of the site, the materials available and the skill or knowledge of the Engineer in charge.

The French sixty years ago developed the modern gravity cantilever masonry dam as one of the forms of retaining wall for deep storage reservoirs, and constructed an excellent example near St. Etienne.

In modern reservoir design and construction it is convenient to divide them into two classes,—storage reservoirs, generally formed by damming up a stream or river, forming the source of the water, and service reservoirs, placed on a high point near the area of distribution. The former are used to equalize the supply and the latter the demand. Owing to the number and size of the fresh-water lakes and rivers combined with the sparse population, the need for storage reservoirs in Canada is limited, but in many parts of the world they form the most important part of a waterworks or irrigation project. Storage reservoirs being frequently of vast extent, running up to many thousands of millions of gallons capacity, and costing millions of dollars to construct, they are a source of physical danger to the downstream populations and properties, and their security is a matter of prime importance.

There have been some notable reservoir failures within comparatively recent times, five of which out of hundreds stand out as catastrophes, involving the loss of over 3,000 lives and much damage to property. The cause of the failure in each case demonstrates certain necessary precautions in reservoir building, and for that reason they are briefly referred to here.

1. The failure of the Puentes Reservoir in Spain was due to improper foundations of a masonry dam constructed to form a reservoir 164 feet deep. The reservoir had been in use for 11 years, but only half filled. The first time the water rose to 154 feet the whole of the material under the dam, which consisted of water-bearing gravel, through which piles had been driven to carry the dam, blew out and discharged the whole contents of the reservoir in a very short time. The loss of life was 608 persons.

2. The Dale Dyke disaster, near Sheffield, England, arose from the failure of an earth or shale embankment, before the reservoir had been put into service. The embankment was of poor, unsuitable materials badly consolidated,. The puddle clay core was badly supported, and the outlet pipes were placed in the made ground under the embankment. Settlement of these took place, and probably some of the pipes were fractured and admitted the considerable water pressure of the reservoir into the loose materials behind the clay puddle sheeting forming the watertight layer, and the whole dam collapsed. Thus, too much care cannot be exercised in building a reservoir embankment, and the outlet works should be constructed in the form of a culvert or a tunnel in the solid, unmade ground, preferably bed rock or shale, and the outlet pipes should be within the culvert and, except at the stopping, where special precautions must be taken, should be accessible for purposes of maintenance. The loss of life is recorded as 238 persons, and a large district of Sheffield was destroyed.

3. The failure of the masonry dam of the Habra Reservoir in Algeria involved the loss of 209 lives, destroying several villages and part of a city. The reservoir was constructed in a semi-arid region upon a large catchment area, and after eight years of service, following a severe storm, covering a large portion of the catchment area, the dam must have been overtopped to the extent of probably 13 feet, which includes the height of a parapet wall. The dam was composed of very porous materials and leaked very badly. The foundation materials were also questionable, and the structure gave out, releasing about 7,000 million gallons, in addition to flood waters. Thus, in this case, the failure was due to the combined effect of inferior workmanship and materials and insufficient provision for the enormous flood discharge.

4. The Bouzey disaster in France was an example of a masonry dam constructed of poor material, in which in addition the middle third provision was not adhered to, and when the reservoir was full there was tension at the face of the dam which the masonry was too weak to withstand. The horizontal crack which formed admitted water under pressure, and the portion of the dam above the crack for a considerable length gave way by overturning. The loss of life was in the neighborborhood of 200 persons.

5. The most serious failure on record is that of an earth embankment at Johnstown, U.S.A., causing the death of over 2,000 persons and millions of dollars damage to property. The embankment was over-topped by a heavy flood, due to insufficient overflow works. The frightfulness of this disaster was much increased by the taking fire of the floating wreckage of buildings, which piled up against a bridge.

"Mexico City, Jan. 19.—More than 100 persons were drowned, and more than 200 others were injured in the disaster yesterday at Pachuoa, when two dams above the city broke and torrents of water swept through the lower sections of this big mining centre, according to the latest reports.

"A thousand persons were rendered homeless. Several mines were flooded, and it is believed the death list will be added to considerably when the shafts are cleared.

"The dams held back water used in the chemical treatment of ores, and many of the deaths were due to the victims being poisoned by swallowing this water.

"A singular feature about the disaster was that the two dams broke simultaneously. The reason for this has not been discovered."—Erindale *Engineering News*, April 14, 1910.

No reservoir of this class is absolutely watertight for various reasons, but while leakage runs clear and does not increase, experience shows there is not much danger; but should the leakage increase or become turbid it is otherwise. Thus it is usual to collect all in detail, examine and measure and keep on record all such leakages.

Every reservoir has its own peculiarity, depending upon the nature of the site which can be selected only after mature consideration, involving detailed studies of the various problems involved, often political as well as technical. Sometimes the construction of a large reservoir involves the diversion of roads, railways and canals, the displacements of populations with their schools, churches and churchyards. The geological factors covering the whole reservoir, as well as that at the dam, must receive the closest attention. It is usually necessary to sink a number of trial holes along the site of the embankment to ascertain the probable depths of the foundations or cut-off trenches.

Examples of various reservoirs are given.

Service reservoirs for water supplies being generally close to populated areas, are frequently covered to prevent contamination from various sources, such as algae growths, wind-borne materials, aquatic birds, mice, frogs, and other reptiles; suicides, the ends of the careers of unwanted dogs and cats and deliberate urinal and faecal contamination. Thus an open service reservoir can be conducted only in select neighborhoods, and where there is plenty of water surface to form a counter attraction. In the construction of these reservoirs there is no essential difference between them and storage reservoirs. They are, however, much smaller; generally the ground is less favorable, and a clean bottom and sides are desirable. The simplest kind of service reservoir is a hole dug in level or sloping ground, and the suitable materials piled in the work of an embankment around the boundary. The inner slopes of the embankment are protected by stones or concrete, and all other parts grass-sown. Of such is the Rose Hill Reservoir used by this city. Another of the same type is the Oswestry Reservoir in Wales on the Vyrnwy Aqueduct, immediately above filters. This example has the advantage of an outlet culvert, which is wanting in the Rose Hill Reservoir.

The size of service reservoir needed by a city must depend largely on the source of the water. If the water is derived from a long distance three days' supply is essential, and a week's supply is not too much. Even where the source is at hand like that of Toronto, a service reservoir is very desirable to help the pumping machinery, and filters over peaks and casualties. The maximum day's demand of Toronto in 1919 is shown (Slide 41). During that one day 18,600,000 gallons were consumed in 16 hours in excess of the average demand for the year. This was partly made up by increased pumping, but the actual demand on Rose Hill Reservoir amounted to eight and one-third million gallons, and ———— from the pure water reservoir at the Island, only part of which could be replaced during the following night. Thus a continuance of a similar demand for several days at this rate would soon have produced a shortage of the supply.

The floor of a service reservoir is frequently protected by concrete, and the embankments by concrete slabs or stone pitching. Frequently the embanking is held up by retaining walls of concrete, sometimes brick-faced. Reinforced concrete has also been used of late years for service reservoir walls. Sometimes both the floor and walls are supported and backed by puddled clay. The reservoirs may be of any plan,—circular, square, polygonal or of special shape to suit the ground. When a reservoir is covered, the roof acts in such a way as to support the

boundary wall against the thrust of the earth embankment. The Toronto Island service reservoir is typical of the covered reservoirs of North America. The groined roof is covered with earth to protect from frost. The roofing in this reservoir is built on the umbrella plan, each column acting as the support to a square of the roof of 13 feet sides. Most service reservoirs leak to a certain extent, principally at cracks or construction joints. This phase would be much worse were it not for the fact that submersed concrete expands considerably, the effect being much more important than temperature effects. In order to get away from the inevitable leakage from concrete reservoir linings, various attempts have been made to use bitumen linings with some success. One of the latest important service reservoirs of this class is the Cross Hill Reservoir for Birkenhead, which appears to be absolutely watertight. The floor is wholly covered with bitumen, and there is a layer of the same material between an inner facing of brickwork and an outfacing of concrete. The walls consist of a series of horizontal arches between counterforts of steel cased in concrete and brickwork. The roof is covered by domes on an hexagonal plan, each hexagon being 30 feet across the flats. The columns are of concrete blocks. This reservoir has a capacity of 31,000,000 gallons, and is 28 feet deep. It forms part of a new supply to be derived from North Wales.

The last slide shows the Norton Tower which forms a balancing tank on the Vyrnwy Aqueduct supplying Liverpool. This is probably the most elaborate example of a raised reservoir in the world. The water surface is 110 feet above the ground, the tank is 80 feet diameter, and 31 feet deep in the centre, and holds 650,000 gallons. The bottom of the tank is an inverted dome of steel suspended from a compression ring on rollers; at the outer boundary the upper parallel portion of the tank is of cast ornamental iron. The masonry of the tower is ashlar throughout, the stones weighing from two to seven tons.

Table of Storage Reservoirs

Name	Date of Completion	Date of Failure	Depth of Water Feet	Height of Dam Feet	Type	Lives Lost	Yield Million Gal. per Day	Storage Millions Gallons
Furens	1866	——	164	184	Masonry	——	9	330
Puentes	1790	1802	164		Masonry	608	——	——
Dale Dyke	——	1864	——	95	Earth	238	——	712
Habra	1873	1881	——	——	Masonry	209	——	6,400
Bouzey	1881	1895	49	72	Masonry	200	——	1,500
Johnstown	——	1889	70	——	Earth	2,000	——	——
Todmorden	1900	——	78	111	Earth	——	1	130
Vyrnwy	1890	——	84	125	Masonry	——	54	12,000
Taf Teehan	In course of const.		90	100	Earth	——	21	3,500
Charme	1904	——	——	——	Earth	——	——	——
Assuan	1903-1910	——	72	112	Masonry	——	——	450,000
Mouche	1890	——	95	——	Masonry	——	——	2,000
Urft	1904	——	166	191	Masonry	——	——	12,000
Craig Goch	1905	——	135	——	Masonry	——	——	2,000
Alwen	1920	——	90	——	Concrete	——	11	3,200
Upper Neuadd	1900	——	80	130	Masonry	——	2	345
Croton	1907	——	185	297	Masonry	——	——	30,000
Eschape	1898	——	116	120	Masonry	——	——	200
Londenon	1904	——	107	123	Masonry	——	——	85
Oswestry	1892	——	16	25	Earth	——	——	46
Roosevelt	1911	——	220	284	Concrete	——	——	420,000
Pathfinder	1910	——	90	210	Concrete	——	——	327,000
Shoshone	1910	——	233	305	Concrete	——	——	149,000
Ashokan	..1917	——	130	220	Concrete	——	500	127,000

RESEARCH WORK ON CURRENT TRANSFORMERS *

By C. Kent Duff, *Research Assistant.*

THE current transformer is a piece of accessory apparatus used in connection with measurements in alternating current power circuits. Its functions are two, namely, to supply the meters with a current which is at all times a constant fraction and an exact miniature of the line current, and also to insulate the meter circuit from the line which may be at dangerously high potential. Actually the current transformer does not supply the meters with a current which is exactly proportional to the line current, because of inherent errors which cannot be wholly avoided. In the case of meters used for measuring large quantities of power for which correspondingly large charges are made, a small percentage error in the current transformer may involve no inconsiderable amount of money, and hence it is desirable to reduce the errors to a minimum.

*Presented before the Electrical and Mechinical Club on December 1st, 1920.

The general principles of operation of the current transformer and the chief factors affecting its errors are fairly well understood, but there are still some points on which our knowledge is quite imperfect. This research work was undertaken with the object of clearing up some of these obscurities. A better understanding of the principles of operation may be expected to ultimately result in better design and more intelligent use of the apparatus.

For the benefit of those to whom the current transformer is unfamiliar a brief description of its construction and a simple explanation of its operation may be made. There are three principal parts to every current transformer, a primary winding, secondary winding and a closed iron core through which both windings pass. In the so-called through-type current transformer the primary winding is not provided by the manufacturer, but a hole is left in the case through which a cable, busbar or other conductor can be passed one or more times to act as a primary. The primary winding is well insulated from the secondary and core and the secondary circuit is grounded at one point in order to keep it at a safe potential. One or more meters, relays or other current-operated devices may be connected in the secondary circuit, all being connected in series, so that the same current passes through each one. The term secondary burden, is used in reference to the constants of the part of the secondary circuit external to the transformer.

The operation of the current transformer may be explained as follows: The current in the primary winding which is connected in series with the line in which the current is to be measured, exerts a magnetizing force which causes alternating magnetic flux in the core. This flux which also passes through the secondary coil induces a voltage in the secondary which causes current to flow in the secondary circuit. This current is almost equal to the primary current multiplied by the ratio of primary to secondary turns, but is never quite so great, because then the secondary magnetizing force would be equal and opposite to that of the primary, which would leave no resultant magnetizing force to magnetize the core. The difference between the primary and secondary ampere-turns, i.e., the exciting ampere-turns are necessary in order to produce the flux in the core. It is this exciting current which causes the errors of the current transformer, and since the exciting current is determined by the core flux, any factors which affect the core flux will influence the errors.

The most important factor which influences the core flux is the impedance of the secondary circuit, which includes both the internal resistance and reactance of the secondary winding and also that of the burden. The secondary voltage necessary to force a given current through the secondary circuit varies directly as the

total secondary impedance, and hence the flux which causes that voltage varies directly as the total impedance of the secondary circuit. It is, therefore, desirable to keep the secondary burden down to a minimum and not to connect more instruments in the circuit than are recommended by the manufacturer.

Another factor which very greatly influences the core flux, and thereby the exciting current and the errors, is one which has been heretofore largely overlooked. That is the effect of leakage flux, i.e., flux which, due to the strong opposing forces of the two windings "leaks" out of the core and passes through the space between the windings. This subject has been extensively studied in connection with this research work, and constitutes the main feature in the results.

Secondary leakage flux causes secondary leakage reactance, which affects the value of the total secondary impedance, and thereby influences the errors. Moreover, the value of this leakage reactance in many cases is found to exceed the internal resistance, and in some instances even eclipses the burden itself in magnitude and importance. Nevertheless, due to lack of information on this subject, many designs and attempted calculations of performance are made without any consideration of leakage reactance.

Other facts in regard to leakage flux which have never been noticed hitherto have been brought out by this investigation. The quantity of leakage flux in the core varies greatly from point to point, due to the "leakage" which is going on. Its distribution over the core cross-section is also far from uniform, and the direction of the path of the leakage fluxes in the core varies from point to point, and seldom runs parallel to the core axis, which is the normal direction of core flux. On top of this variable leakage flux we have superposed the working flux which is practically uniformly distributed throughout the core. The combination of all these fluxes determines the exciting current, which is naturally found to be quite different from that calculated on the usual assumption of a uniform flux distribution. That the observed difference is really due to the effect of the leakage fluxes in the core was proved by constructing a current transformer in which the leakage reactance was reduced to a minimum and leakage fluxes kept out of the core. The results show conclusively that the leakage fluxes have a marked effect on the errors.

A complete report of these investigations will shortly appear in the Bulletin of the School of Engineering Research.

ENGINEER—HUMAN FACTOR *

By Wills MacLachlan, *Electrical Engineer, Toronto, Ont.*

ON the walls of the Engineering Societies Building Library, New York City, is found the following definition:

> "Engineering—the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race."

From this definition you will see that engineering has two sides—one technical detail information of the forces and materials of nature—the other the psychological information used in organizing and directing men. In your course of studies at the University, you are giving primarily attention to knowledge of the technical details of the materials and knowledge of the forces of nature. To a limited extent you have the opportunity in your societies, clubs and teams in the University of obtaining a knowledge of organization and the faculty of directing men.

After you graduate, I feel that it is very essential to obtain practical experience in engineering work in the field before you attempt to carry out the principles that you are studying in what might be called an office position. Practical experience will give you intimate knowledge of the processes of manufacture and construction, and it will also give you an insight into that most important factor in an Engineer's training, viz: the study of human nature. One point that must be learned is to respect other men's station in life. Some, possibly have not the ability that you have, and a great many others, although possessing the potential ability, have not had the opportunity of carrying on their studies, but have had to leave school at an early age and go right into life's work. Your course as an Engineer will be made considerably easier if you make up your mind to always respect the station of any man, whether holding a position higher or lower than your own. Practical experience will always give you the opportunity of studying various forms of business organization without which it would be impossible to carry on business as we find it to-day.

Fifty or one hundred years ago, factories and business organizations were of comparatively small type. The touch between employer and employed was intimate, in many cases the employer working at the bench along with his workmen and apprentices. At that time the steam engine was just coming into the industrial field, electrical motors were not known and compared with present-day machinery, the speed was very slow. With the small plant it was found that living conditions were not nearly as crowded as we find them to-day. Our huge manufac-

*Presented before a meeting of the Mechanical and Electrical Club on January 24th, 1921.

turing centres were not in existence, and men lived a far more normal life. In the growth of plants, the speeding-up of machinery, the enlargement of organization and the strain of present-day business, we find that upon workmen and executives there is a constant strain that was unknown 50 or 100 years ago.

Growing out of this condition there has recently developed in industry an effort to solve for present-day conditions, a number of problems, some of which did not exist in the earlier types of factory and some of which were easily solved due to the intimate touch between employer and employed. The question of the prevention of accidents has received possibly more attention in the last five years than in any previous five years. The State has ruled that industry must assume the costs of accidents in the industry and, leaving the humanitarian element out for the present, it has been found good, sound business to institute accident prevention organization into the industry, and in this way save costs of the accidents, as well as prevent disorganization of staff due to accidents. It has also been found that the doctor and nurse, by giving their attention to industrial problems, can be of very considerable assistance to industry. The average industry losses possibly one and one-half days per employee per year due to accidents, but it loses about seven and one-half days per employee per year due to sickness. The activities of the medical staff, therefore, have been very helpful in reducing this loss. They have also been a very important factor in establishing the intimate touch between employer and employed, which existed in the smaller organization. Quite recently, matters of labor turnover were receiving the attention of executives; for instance before the war the U.S. Steel Corporation found that it cost them approximately $40 to hire and fire a common laborer. In a large organization employing and discharging a number of men, you can readily see the leaks that should be stopped. It is often found that a man employed for one position will not make out very well, but when moved to another position in the same organization will carry on successfully. The question of promotion in a large organization also has to receive very careful attention, or some men will receive possibly more than their due share of recognition, while other men will not have justice done to them. These items lead, naturally to centralized employment, job analysis and the placement of men, a matter that is receiving more and more attention as time goes on. Men who are not employed in an industry are to a very large extent raw material. Coming into a large organization, men have to be trained; even for skilled workmen it is necessary to train them into the particular processes that that organization is carrying on, and for young boys apprenticeship courses are receiving more and more attention. It is hoped that some day a more general application of the idea of Engineering Apprentice-

ship Courses will be given consideration. It is hardly necessary for me to point out that these various industrial relations in industry have to be correlated, and there has developed the work of the Industrial Relations Department having charge of these items, together with a number of others that I have not time to discuss.

In a very large organization, it has been found to be of at least an advantage to have some organized contact with the employees; this is commonly called "Employees' Representation," and two general plans are followed. One known as the Whitley Plan is commonly in use in Great Britain, being developed a few years ago by a committee of the House of Commons under the Chairmanship of Mr. Whitley. In a given industry, a committee is organized half representative of the employers' organizations, and half representative of Trade Unions in that particular industry. This committee represents to the Government the industry and is dealt with by the Government. Under this Committee there are District Councils and in a particular workshop, a Shop Committee, the basis of representation being in all cases representatives of the Association of Employers on one side and representatives of Trade Unions in the industry on the other. The only example of the Whitley Plan in effect in Canada is in the Building Trades.

Another plan known quite generally is the International Harvester Plan, and is comparable to the Works Committee of the Whitley Plan with the exception that the Works Council is composed half from representatives of the management and half from elected representatives of the employees of the plant, without any reference to whether or not they are members of unions or non-union members.

The plan of representation of employees has been put into effect in a number of plants. Matters that come up for discussion vary, but in general wages, hours of work and working conditions are discussed and a policy worked out; usually the execution of this policy is left with the management. Any one of you would do well to study the question of employees' representation as, at the present time it looks as if it would became very general.

I must apologize for the hasty way in which I have dealt with a number of subjects, any one of which would deserve very careful and serious consideration.

It is every citizen's duty to take an interest in the work of his country and in the Government of it, otherwise he can hardly be called a free man, if he does not execute the franchise and the liberties that have been gained for him in days gone by. You who have the opportunity of becoming professional men have added to your responsibility as a citizen an even greater responsibility in that others who have not the opportunity that you have, are, through their taxes helping to pay for your education. It

is therefore, only to be expected that you will take a far greater interest in public affairs and lend your influence to develop your country in logical and sound ways, which ideas, I am sorry to say, have not been given the consideration by engineers in the past that they should have.

In closing, I would like to leave just two thoughts with you:

1.—Be an Engineer, do not be only a technician.

2.—Know men as well as things.

If you can talk with crowds and keep your virtue,
  Or walk with kings—nor lose the common touch.
If neither foes or loving friends can hurt you,
  If all men count with you but none too much;
If you can fill the unforgiving minute,
  With sixty seconds' worth of distance run—
Yours is the earth and everything that's in it,
  And—which is more—you'll be a man, my son.

TOOTHED GEARS

By Chester B. Hamilton, Jr., B.A., Sc., M.E., '06, S.P.S.

THE subject of toothed gears is so complicated and so many-sided that it is difficult to take a comprehensive view of the matter unless some definite and orderly scheme is adopted in the first place. For our present purposes we will consider gears according to the different methods by which they may be classified.

First let us consider gears according to the material of which they are made. This may be non-metallic, or metallic of non-ferrous nature or ferrous, the latter either cast or wrought. All gears were originally made of wood, and we see a survival of this in the mortice wheels with inserted wooden cogs which have until recent years been good practice for water-wheel and similar mill drives. The cogs were of hard maple boiled in tallow. The modern practice is to use metallic gears in all such cases and confine non-metallic material to such applications as the rawhide pinions used for obtaining silent operation at high speeds on electric motor and similar drives. Fibre is also used to some small extent, but is not a good gear material on account of its weakness. Bakelite, under various trade names such as Micrada and Celeron, is an excellent gear material, particularly for wet or oily locations where rawhide would be somewhat at a handicap.

The non-ferrous metallic gears are practically always bronze except in quite small work, where brass with its cheaper price and free cutting qualities is desirable. For any job where the power transmitted or the durability of the drive is seriously con-

sidered, it pays to use bronze of a good grade, because its strength is greater proportionally than the price increase over brass. The most commonly used formula for gear bronze is 88 per cent. copper, ten per cent. tin, two per cent. zinc. For worm gears phosphor bronze of the following proportions is frequently used, and is a very high grade and satisfactory material: 89 per cent. copper, 11 per cent. tin, .01 to 03. phospor and not over .05 lead or zinc.

The cast ferrous materials are cast iron and semi steel, both made in the ordinary foundry cupola, and steel castings which may be made by the open hearth or electric furnace process. The Bessemer or Tropenas converter process is not considered to produce good enough castings for gear work. The most suitable material for steel castings is about .25 per cent. carbon with low phosphorus and sulphur. The wrought ferrous material is steel only, as wrought iron is not a suitable gear material. Both the ordinary carbon and the alloy steels containing nickel, chrome, etc., are used. The latter are always heat treated, as their full value is not obtained otherwise. There are two forms of heat treatment, for which different grades of steel are required. A low carbon steel of .10 to .25 per cent. carbon may be used for case hardening, or a higher carbon steel, in the neighborhood of .45 per cent. for hardening direct from the fire by quenching.

As the purpose of gearing is to transmit power and motion between shafts it is evident that a classification of gears according to the relaxation of their axes will be a basic classification.

Gears with shafts parallel are spur or helical gears, according as the teeth are straight or laid out on helical curves on the pitch cylinder.

Gears with shafts at an angle, but lying in the same plane, are bevel gears, and their pitch surfaces are cones whose apicies coincide at the point of intersection of the two axes. The teeth of these gears are usually straight and laid out on converging lines towards the cone centre, but they may also be curves developed on the pitch cone surface.

Gears with shafts at an angle but in different planes are commonly called either spiral or worm gears. The word spiral in this case is, however, a misnomer, as the teeth are helical. A pair of helical gears are both cylindrical and, their teeth being made up of convex curves, and their axes at an angle, there is only point contact between their tooth surfaces. A worm and worm gear pair of usual form comprise one cylindrical member, the worm, and one with concave face. Thus the gear embraces the worm around part of the circle, and therefore instead of point contact there is line contact between the teeth-like spur gears and greatly increased load-bearing ability. In the special case of the Hindley or Hour-glass type of worm, both worm and gear embrace each other, and in this case instead of line contact we

find surface contact over an area of tooth face.

Gears may be classified according to the method by which the teeth are produced. Without going into details beyond the scope of this article the methods may be listed as follows: (*a*) Teeth made separately and set in mortices in the gear rim. (*b*) Teeth cast in the foundry, being moulded the same as the body of the gear. (*c*) Teeth machine cut from turned gear blank. (*d*) Teeth rolled into the rim of the gear at a forging heat by rolling the job with a toothed master gear. (*e*) Teeth may be ground to finished shape, usually after being roughly cast. (*f*) Teeth may be stamped in a punch press from sheet metal as clock gears are made or drawn through a die as pinion wire.

Another classification of gears is according to the form of the tooth. Very early gears had merely a round pin or peg. This was followed by the cycloidal tooth form which is now obsolete. Next came tooth forms based on a circular arc or two portions of arcs of different radii. This in turn was displaced by the modern involute tooth curve, which is in practically universal use to-day in one or other of its two forms, (*a*) the true theoretical involute and (*b*) the empirical modification first developed by Brown & Sharpe.

Tooth forms also vary in two other ways as well as kind of curve, namely, (*a*) in pressure angle, usually $14\frac{1}{2}$ deg. or 20 deg., and (*b*) in ratio of thickness to depth of tooth, that is, whether the tooth is standard depth or of stub form.

Again, gear teeth may be classified according to the method, tool and machine used in producing the tooth curve. This applies exclusively to cut gears. (*a*) The first method is the use of a formed tool, which may be either a disc form milling cutter, or an end milling cutter, or a formed planing tool for straight line action as a planer or a broach. (*b*) The second method is the use of a formed template which controls the motion of a tool which itself is not formed, but describes by its motion the required curve on the job as it is fed into the cut. Machines based on this principle are made for both spur and bevel gears. The former have motion along the straight line elements of a cylinder, and the latter along the straight line elements of a cone.

(*c*) The third method uses neither formed tool nor template, but generates the tooth curve mechanically from the motion of the machine. This class includes the Gleason bevel gear generators and the hobbing and planing types of generating gear cutters for spur and helical gears.

The applications of gears to the transmission of power may be classified according to the requirements of the service under the following divisions, (*a*) very light service,—to transmit motion only,—as in clocks, meters and models; (*b*) rough, slow service—to transmit load at negligible velocity,—as hand-operated winches, some slow feed motions, etc. (*c*) to transmit load with

a velocity factor—this constitutes the general run of gear applications; (*d*) to transmit load with velocity and also with an allowance for shocks.

Another method of classifying gears according to service is based on the quality of the requirements as to accuracy. The following classification is from the standards of the American Gear Manufacturers' Association: (*a*) Precision gears for aircraft and printing machines; (*b*) automobile and machine tool grade of quality; (*c*) standard jobbing gears for pumps, hoisting and general industrial gearing.

In the brief space available it has not been possible to go into technical details on this subject, nor give the specific information which would otherwise have been desirable. If any of the readers of this paper are interested in gear application to the extent of desiring further information, the same is available in printed form in the engineering data sheets published by the Hamilton Gear and Machine Company, Toronto, of which company the writer is President and Engineer. These will be mailed to anyone who will state the phase of gear work he is interested in. This is not advertising, but technical data.

STRUCTURAL ENGINEERING AS A SPECIALTY

By C. R. Young

Associate Professor of Structural Engineering, University of Toronto.

ENQUIRIES are frequently made by young men, both in and out of college, concerning the prospects offered in the special field of structural engineering, and the nature of the work encountered therein. So ramifying are the activities of the structural engineer, that it is not remarkable that knowledge of the real character of his work is less general than, perhaps, of any other well-established engineering specialty. To the end that those interested may be guided to some extent in any decisions they may make in the matter of entering this field, the character of the work done by the structural engineer, the personal qualifications required and the prospects offered are briefly set forth in what follows. It is not the intention either to influence hesitating persons to enter upon such work or to avoid it, but merely to sketch the present and probable future status of structural engineering.

Many Contacts of Structural Engineering.

Structural engineering has not that narrow significance which is commonly attached to it by the layman. Familiarity with structural steel, arising from the widespread use of that material in building construction, has frequently led the public to regard the structural engineer as one whose duties have to do solely with

the design of the steel-work for buildings. On the contrary, structural engineering, properly speaking, comprises the design, construction and investigation in so far as strength, rigidity, and economy are concerned, of all load-bearing structures in all practicable materials. Works, in the planning and execution of which structural considerations are of basic importance, are surprisingly numerous. They include, for example, bridges, buildings for all purposes, foundations, culverts, piers, abutments, retaining walls, sea-walls, docks, landing stages, elevated railways, subways, tunnels, tanks, reservoirs, standpipes, gas-holders, transmission line towers, wireless towers, dams, pipe-lines, flumes, penstocks, sewers, conduits, locks, lock-gates, grain elevators, headworks for mines, ships, cranes, crane runways, cableways and chimneys.

Resourcefulness Essential

The broadly-trained structural engineer should be equally proficient in the use of steel, iron, concrete, stone, timber, brick, tile and all other materials which experience may show to be adapted to the purposes of the construction in hand. He should be able to use whatever materials are available for the construction of emergency works, as, for example, a firm of eminent consulting engineers once did in the rapid construction of a hemp rope suspension bridge to carry an important water main across a wide and turbulent river after the regular bridge had been carried out by flood. In the tropics, the well-grounded structural engineer should be able at short notice to erect bridges and buildings from bamboo and lashings, if more suitable materials are not at hand.

From the above partial enumeration of the many types of work to which the application of structural knowledge and skill is required, it is evident that the work of the structural engineer cuts across the lines usually prescribed for the engineer in charge of railway, highway, harbor, sanitary, hydraulic, mechanical, electrical and mining work, quite as much as across those laid down for the architect. No one of these practitioners can carry on his work without in some measure requiring structural services, whether supplied by an outsider, by himself, or by some member or members of his staff.

What Does the Field Offer?

But although the necessity for applying structural knowledge and experience to the solution of innumerable constructional problems may exist, what has the field of structural engineering to offer those who enter it? What are the chances of remunerative and continuous employment, and what is the opportunity for rising to positions of increased responsibility and prestige? What is there lying beyond or outside this field to which a trained structural engineer might gain access, and in

which success might be won? To what extent does work in this sphere admit of taking a progressive part in public affairs, or facilitate the development of good citizenship?

Getting a Job.

Recent experience indicates that it should not be difficult in times of reasonable constructional activity for a young man with some structural training to obtain employment in this field. Those in charge of employment bureaux for engineers have usually found it difficult to fill all enquiries for structural men, coming, as they do, from employers engaged in a wide range of work, which may, in many cases, involve structural problems only incidentally. The companies fabricating structural steel work for bridges, buildings and the like are usually in the market for draughtsmen at the outset of the constructional season. Engineering and contracting companies employ many technically-trained men on design and supervision of construction. Municipalities and consulting engineers require designers, draughtsmen and inspectors on a great variety of work, portions of which are of a structural character, and manufacturers frequently aim to have some one in their employ who can design and carry out extensions without the necessity for employing a special outside engineer. It may, therefore, be stated that under normal conditions, constructionally speaking, there should be a good demand for men to fill structural positions. The beginner must, at the start, however, expect neither remarkable salary nor commanding position, but merely the opportunity to exhibit his capacity for getting on in the work. Tracing, making blue-prints, testing rivets or counting sacks of cement may not appeal to the young graduate as a finality, but by these lowly routes many outstanding figures in the engineering world have attained the places they now occupy.

Relative Compensation

Whatever may be said of the relation at present existing between the compensation of engineers and the services rendered by them, it will be generally admitted that the structural engineer is no worse off than the specialist in any other branch. In fact, subordinate positions in this field have hitherto been offered salaries at least as good as, and often better than, those attached to corresponding positions in other branches. In one instance, known to the writer, a large manufacturing company paid salaries to structural draughtsmen considerably in excess of those paid to mechanical draughtsmen employed in the same room, although the latter were required to possess qualifications quite as high as those possessed by their more highly-paid associates. Of course, here, as in every other department of human activity, remuneration is a function of the demand for one's services. Gen-

erally speaking, up to the present, the demand for men with structural training and experience has been in excess of the supply. With any marked reduction of construction operations, this relation might be reversed, but if the material development of the country is to proceed at any thing like the rate maintained for the past decade or two, the man who is able to design structures and carry them to completion in the materials which he finds to hand is not likely to find his service a drug in the market.

Continuity of Employment.

Regularity of employment is an important factor with those with responsibilities and homes to maintain. Except in times of general depression, which seriously affect all branches of engineering through the suspension of all work except that of the most immediate necessity, structural operations in office and field are quite as constant as those incident to any other type of engineering work. While the severity of our climate precludes the conduct of much outside work in winter, judicious employers will not suffer an organization to go to pieces through the loss of competent and trusted men, so that if the field engineer's particular duties all but disappear with the advent of cold weather, work is found for him in the office till the next construction season opens. Inside men in the employ of large contracting or construction companies, or in the offices of prosperous consulting engineers or architects, enjoy a continuity of work comparable with similar men engaged in business of other kinds. The incompetents will be allowed to go, and the good men will be tided over the dull periods.

Opportunities for Advancement

Qualifications of such high order are required of the thoroughly competent structural engineer that his value in an organization naturally brings promotion, often to broader fields of work. This creates opportunity for advancement in all the grades below. The designer, estimator, checker and draughtsman all move up one step. If to be in the outside organization, the superintendent may become manager of construction and the inspector may become superintendent. A young man with a thorough structural training and sound business sense is very likely to go far in the construction industry. Great construction organizations, both public and private, are always in search of men who possess both technical and administrative capacity to take responsible executive or managerial positions, and when such men are found, advancement is the natural outcome.

Private Practice

For those structural engineers whose experience and attainments are such as to place them in the front rank, there is some opportunity in private practice. It frequently happens that

an organization or municipality requires the services of structural specialists on a specific piece of work extending over a limited period. Rather than attempt to build up an engineering organization of its own to be broken up in a comparatively short time, it delegates the work to a private firm of engineers, with resulting economy and expeditiousness. Where many cases of this sort arise in a community, the foundation for a successful private practice is created. It should be pointed out, however, that there is a growing tendency for organizations to carry their own structural engineers as permanent officials, or, if not, to seek "free" engineering services through asking contracting companies to submit complete designs as well as tenders. This latter practice very much cuts into what was formerly the field of the consulting structural engineer, particularly on highway bridge and building work. The client has so far failed to understand that he cannot get something for nothing, and that leaving everything to the contractor without adequate check, is a dangerous procedure. The tendency for governments and commissions to furnish free engineering services, as in the issuance of standard bridge plans, also interferes, to some extent, with the field of the private practitioner. Nevertheless, there are many problems which require special treatment, investigation and study, and here the private expert, if he be in truth an expert, will often find a demand for his services. Disagreeable though it may often be, court work offers legitimate employment for a structural engineer of experience and prestige—one who can with certainty state whether a piece of construction is good or bad.

Getting Into Business

Those young structural engineers who have a taste for outdoor life and some capacity for business, who know values and can get things done, very frequently find contracting attractive. It offers an opportunity of utilizing to advantage, at one and the same time, hard-won technical attainments and the instinct of the trader. For one who is well equipped with both, this field frequently offers large financial rewards, and for this reason, no doubt, very many men attempt to enter it. Success here is, however, no more certain than in any other field, and very many contractors, failing to establish a profitable business, revert to pure engineering, for which they find themselves, after all, better fitted. While technical knowledge may be of very great assistance to the head of a construction organization, it should be remembered that contracting is a highly specialized business undertaking. The one who can assemble an organization of technical workers and so direct it as to carry out smoothly and accurately a projected enterprise is the one most likely to attain success in contracting, whether he personally is a technically-trained man or not. In general, structural training is invaluable to a contractor,

for it is the carrying out to the letter of the designer's plans in concrete, steel, timber and the like, with which he is charged. Unless he has business sense, however, he cannot hope to succeed.

Many young men with a knowledge of the uses to which materials, machines and devices are put in construction, and who possess a liking for business, enter sales work with supply houses. Excellent opportunities for advancement, with attractive salaries meanwhile, are often available for the right men, with supply firms handling cement, steel, tile, brick, stone, timber or contractors' equipment. A young man who makes good in work of this kind will generally find it easy to pass into important and remunerative executive or managerial work, often in fields only remotely connected with engineering.

FIRE PREVENTION

By A. L. Irwin, 2T1

FROM the beginning of time fire has played an important part in the evolution of the world. Without the heat from the sun there would be no life here; absolutely everything depends on it, and it is the basis of all the progress and change in the universe. But we are not dealing with solar rays and the highly interesting phenomena of heat and light now—we have in mind mere fire, the combustion of inflammable materials by ignition and the destruction or damage to many materials by exposure to heat developed by fire.

Fire has made and unmade continents; it has been turned into steam, light and electricity, and with it nine-tenths of our food is prepared. Properly under control it is man's greatest servant, whilst unharnessed and running amuck it can destroy in an hour what nature has taken centuries to make and what man has spent a lifetime in fabricating.

Ever since man left his early life in the caves of the earth and has lived in communities; in the fashioning of his many kinds of habitations, he has, in his choice of inflammable building materials laid, as it were, the foundation for the conflagrations and terrible fire waste of the present day. His early huts were of skins and as time went on he built with wood and other combustible substances, a practice which has been continued to even the present day. Thus we have a situation in which these materials of construction, combined with ignorance or carelessness on the part of man furnish all the requirements for a wasteful and desolating fire menace.

With this state of affairs persisting we have surely a great need of increased care and better education for the people in the matter of fire prevention. One authority states that in the matter of fires carefully tabulated for twenty years , proven care-

lessness alone has caused more fires than electric wires, lightning, cyclones or explosives all put together, in the same space of time. Thus it goes on, year after year, destroying life and property until the point has been reached when every man, woman and child in the Dominion must be made to realize that this national phantom of death and destruction must be subdued and that not merely fire *protection* supplied, but the broader science of fire *prevention* practised.

Wasteful conflagrations occur everywhere, out in the wilds as well as in civilized parts. Millions of dollars worth of timber lands are destroyed every few years by forest fires, although it is certainly very gratifying to know that the system of "fire ranging" and the patrolling of the forest lands during seasons when fires are likely to occur is surely controlling the loss by fire from this source. The prevention of fires in more thickly populated centres covers a very wide field and is closely allied to every phase of the life of the people. In order to describe the various means of fire prevention which can be practised in all the different branches of industry as well as those suggested for the homes, one would need volumes, so the writer intends to confine himself to the subject of fire prevention in the industries with which he is most closely connected, namely the metallurgical and other industries allied with the production and manufacture of metals and metallic materials.

In no industry is fire used so extensively as in the metallurgical industries, and on account of this no settlement or community of people is so much in danger from fire and conflagration, as those in which metallurgical industries are centred. On account of the need of metals of various sorts in the construction and equipment of factories and dwellings these metal plants must needs be situated in centres of civilization, hence the risk is indeed greater than if they could be placed out in the more sparsely settled sections.

What then are the precautions that should be taken to insure the safety of these people's lives and homes? Care, diligence and the same practice of fire preventive measures must be practised by both the people and the industries.

Let us first consider the construction of such plants. An engineer about to build a plant of the nature under discussion must necessarily choose from several types of construction, and in his selection the governing considerations should be cost, safety, durability and fire protection, while many minor factors also enter the case. Four general types of buildings are available, viz.

1. Frame construction.
2. Mill or slow burning construction.
3. Steel construction.
4. Reinforced concrete construction.

Although the frame construction is cheap, its lack of service and its extreme fire risk exclude it from use about metallurgical plants. In plants which have the idea of absolute fire-proofedness embodied in them, even the slow burning construction of huge, heavy wooden beams and joists is done away with, because of the necessity of having nothing but non-combustible material used in their make-up.

Steel construction and reinforced concrete are, however, used largely in the construction of buildings, housing blast furnaces and roasting and refining furnaces. In this type of building the skeleton-like steel frame work with corrugated iron roofing and sides is very much the rule, and reinforced concrete is only used for second floors in a few odd cases.

Besides the general make-up of the building are the many little details which go to make up the efficiency of the fire prevention crusade in the plant. Around many smelting and refining plants one sees old wooden shanties used as tool or stock rooms, quite within reach of sparks and easily ignited. These could be replaced to a great advantage with corrugated iron houses. All electrical lines should be carefully enclosed in iron conduits and electric overhead cranes operating in the building should be protected from the heat below by a bottom of asbestos board. The burning out of motors and control boxes caused by this overheating is quite common, and there are cases on record where the oil and grease present as lubrication caught fire and badly burned the operator before he could dismount from the crane.

Departmental offices used by foreman and superintendents should be constructed of brick and have roofs of slate or tile. In many smelters are still seen the old-fashioned wooden bins for storing ore and flux as well as coke. These bins are a source of danger from fire and, peculiarly enough, in most plants, although situated quite near the furnaces to ensure easy charging, they are not accessible to any high pressure water system. They are generally constructed of a skeleton framework of wood and boarded up with two in. boards. The one remedy for this condition is the introduction of steel bins with hopper bottoms and loaded by conveyor belts, thus eliminating the fire risk, and instead of having to build wooden trestles to carry the ore trains over the bins, the cars are discharged onto the belts and the bins filled in an economical method.

The function of the cars carrying material to the furnaces, is in many plants to carry the charge over the top of the furnace, stop, discharge the load, and move off for another load. At times when the furnaces get down quite low, due to a holdup in the charging for some reason, hot flames issue from the furnace tops and, the cars , if electrically operated, are in danger of becoming overheated and the motors burned out. They should be,

therefore protected by having an asbestos board placed on the bottom of the electrical motor and equipment.

Refineries, brass works, and ornamental metal industries are extensive fields for the exercise of fire prevention. They are, as a rule, situated in the heart of industrial districts, and on account of the nature of the work done, must be closely guarded against possible fire.

They are quite often built of brick and of steel frame construction. Reinforced concrete is also becoming a great factor in the construction of buildings to house these industries, because of its great fire resisting properties. Concrete floors are generally the rule and any wooden window frames or interior fixtures are covered with a coating of iron oxide paint.

In electrolytic refining rooms precautions must be taken to prevent fire from defective electrical installations. Foremen should be made inspect all connections daily and see that the electrical staff repair any major breaks. One improvement noted in some plants is the replacement of wooden slat or board walks between the refining tanks by a flooring of asphalt and slag roofing over tiles, in order to prevent spontaneous combustion due to the action of nitric acid fumes on the wood, a thing quite common in plants using this in their process.

In addition to the general construction of plants, and works in the metal industries in order to keep fires down to the minimum, Departments of Safety and Welfare are organized, which have the matter of fire prevention as a large portion of their work. Notices, pictures, cartoons and placards are placed conspicuously about the plants, exhorting the employees to greater care in the prevention of fires, and give many examples of how fires are started by carelessness on the part of men working in the different departments. Receptacles of sheet iron are placed generously throughout the plants, and the superintendents and foremen are instructed to see that all paper, rags and waste material of a combustible nature are placed in these cans, and that they are emptied regularly every day. Fire extinguishers and fire hose, as well as buckets to be used in case of fire, are placed at strategic points about the plant, and most plants of to-day have a fire alarm system connected with the engine-room where, when an alarm is rung in, the engineer gives a signal on the whistle indicating the position of the fire and volunteer fire brigades are smartly on the scene of the fire. Fire drills are held from time to time to keep up the standard of the brigade.

It is essential that all oils and explosives be kept in houses by themselves or in tanks underground, and that no smoking or naked flame of any sort be allowed near them. Regarding waste oil in old cleaning rags or engine waste, most plants have in their engine rooms centrifugal waste cleaners in which the oil is separated from the oily waste material by whirling about in per-

forated drums filled with live steam. The centrifugal force developed throws the oil to the outside of the cylinder and through the perforations into another surrounding container, and in this manner a great saving is effected, and the danger of oily waste lying around is quite eliminated. The foregoing illustrations go to show what can and is being done along lines of fire prevention in plants in the metal industries, and many of them are common to most industries where fire plays a large part in the programme of operations.

We must also think, however, of the homes of the workers and what measures should be adopted for the prevention of conflagrations, which might possibly result in the destruction of life and property. Of all classes of buildings, houses contribute by far the greatest number to fire, because people still insist on having homes of more or less wooden construction, although many are learning the folly of flimsy buildings. Many people, too, believe that as long as they have the outside walls of their houses of brick or stone, and the roof of tile or slate, that they have fireproof homes. Such is not the case, for as soon as a fire gets going in the wooden rafters or floor joists, the outer walls only act as a furnace in which to burn up the interior, endangering lives and ruining valuable household possessions. The best plan is to have the outer walls of brick, terra cotta or concrete and the floors, partitions and roof of absolutely non-inflammable material. The lengthened life of the structure and the saving in fire insurance and fire loss soon overcomes the extra expenditure, to say nothing of the ease of mind secured.

It is a mistaken idea, too, that houses of fireproof material are unattractive and flat-looking. In the hands of a skilled architect they can be made beautiful examples of the best in home decoration and design. Many fine houses suitable for occupation by the working man in the industries are being constructed nowadays of tile, stuccoed externally; an inexpensive construction whic is fireproof and does not call for the more expensive steel construction.

Fire insurance is looked upon by many people as a protection to their homes, but is it? True, it repays in many cases nearly the value of the edifice destroyed, but it does not recover the lost articles which are of more than intrinsic value to the owner, nor yet eliminate the possibility of loss of life. Insurance in some form or other will probably be always necessary, but the sane course to take is to build so that insurance need only be carried on the contents of the home and to carry out simple procedures to prevent the occurrence of fires that are a menace to both building and inhabitants.

To arouse the people against the fire foe is the task of those interested to-day. The average citizen would, if presented with statistics, undoubtedly admit that our fire waste is in the form of

a national disgrace, but the great problem is to make him do something to remedy conditions. The remedy is to bring home to him the gospel truth of fire prevention, which is the science of so constructing, protecting and occupying buildings as to minimize the danger of fire, and should not be confused with the narrower definition of fire protection. A fire department appeals to our love of the dramatic, but it is complicated, costly and only too often inefficient. On the other hand, fire prevention with its unbounded scope for efficiency is simple and inexpensive.

No man may directly commit murder or destroy the property of others, no matter how much inclined to do so, and, therefore, equally no man should be permitted to do either of these things indirectly by needlessly, carelessly or selfishly refusing to take the necessary precautions to prevent dangerous fires.

So the movement must be popularized. Organized methods must be adopted for bringing the significance of the fire peril before every person and for the passing of laws compelling the practice of fire prevention. Let the people once realize the exact facts of their own negligence, and they will be swift to provide the cure.

MODERN ENGINEERING PROJECTS *

By T. Kennard Thomson, S.P.S. '86.

MR. PRESIDENT and Gentlemen of the Engineering Society. I certainly appreciate the honor and opportunity of addressing you to-day, and I never miss an opportunity of coming back to the Old School when it is possible for me to come.

This continent is now in one of the most critical stages in its commercial history, and I trust that you gentlemen of Toronto will do your utmost to prevent any monumental errors similar to those in the past, when the development of the St. Lawrence and Niagara Rivers is considered. A treaty with the United States of America will be necessary, and the entire matter should be taken up as one international unit.

It sounds like a paradox to say that a successful business man is naturally narrow-minded, but, on the other hand, there really seems to be some ground for such a statement, as most men succeed by concentrating their energies in one or two directions, and after they have reached the top rung of the ladder, they, forgetting that their experience has been limited to comparatively few lines, give their opinion freely on many subjects of which they know nothing. Or on the other, as the President of a great Chamber of Commerce once told me, his Chamber of Commerce would never endorse any project until that

*Address delivered before a meeting of the Society on November 12th, 1920.

project was an assured success. This being on the principle that the members who had reached the top rung of the ladder through business sagacity and good judgment, were not going to jeopardize their reputation so gained, by endorsing something which might not be eventually carried out.

It seems a great pity that very recently this point of view has been taken in many parts of the country, Boston, New York, Buffalo, Montreal, etc., by some individuals in each of these places, against the deepening of the St. Lawrence River and the development of the water power in the Niagara and St. Lawrence Rivers carried out on a rational basis would result in from six to eight million horsepower a year being developed, and the saving of from sixty to eighty millions tons of coal a year. This would result also in a dozen manufacturing centres, each greater than old Pittsburg, on or near these two rivers.

The chief cities to be benefited by such an undertaking would be the very ones just mentioned as so strenuously objecting to this great undertaking, although, as a matter of fact, every part of North America and many other parts of the world would be benefited.

Even apart from the great industrial centres thus created, the saving of cost of handling wheat and other products of the farms of the Canadian Northwest and the great Western and Central States alone would benefit the entire continent.

It seems hard for many to realize that the country is like a human body, and anything that injures one part of it, injures the whole; the most insignificant splinter in the finger being sufficient to upset the whole system. It is hoped that you will pardon the allusion to such common and well known conditions, but there is really great danger of such an elementary mistake being made at this most critical stage in our economic history.

Some years ago the former President of the New York Central Railroad made a remark that some people thought that his road was antagonistic to the Panama Canal, and he very truthfully stated the fact that the Panama Canal could not but help build up the Pacific Coast, and that anything which built up the Pacific Coast must naturally benefit all the great Transcontinental Railroads.

For the same reason the creation of the great manufacturing centres at our northern boundary would keep all the railroads, canals and other industries of the country busy.

One of the great blunders in history was the New York Barge Canal which replaced the old Erie Canal.

The old Erie Canal was built originally with a four-foot depth from 1817 to 1825, and was really a wonderful undertaking, considering the appliances and the wild country it was carried through. It cost about $7,000,000 and collected its

entire cost through tolls by 1832, although it reduced the cost of freight from $100 to $30 a ton.

It was enlarged and deepened several times, and tolls up to the time they were abolished in 1882, brought into the State something like $135,000,000 or about $9,000,000 more than the entire amount expended on the Erie Canal up to that date.

The economic blunder referred to consisted in turning the Erie Canal into the so-called Barge Canal, which means that no boat standing more than fifteen and one-half feet above water could pass under the fixed bridges of the new Barge Canal.

This expensive blunder was made in order to placate the people of Buffalo, and to obtain their vote for the project; while, as a matter of fact, the people of Buffalo voted against the entire project anyway.

This very short-sighted action of Buffalo was on the assumption that if the lake boats could pass through the enlarged Erie Canal, Buffalo would be handicapped by the loss of the employment of stevedores now due to the unloading and reloading of ships in Buffalo. They might have known that work resulting from enormously increased traffic which passed through the canal would have given Buffalo a great boost, and it would be just about as stupid for people to say that if the New York Central Railroad discharged all of its ticket choppers and porters that the business of New York City would be ruined.

It is also on a par with the opposition against the First Railroad in America, when horse owners combined to fight the railroad project, thinking that there would be no use for their horses after the construction of such railroads.

None were more surprised than these same horse owners when they found that far more horses were required than ever before to handle the merchandise to and from the railroads.

The deepening of the St. Lawrence and development of water power in these two rivers would result in a solid city on both sides of the boundary line from Lake Erie and Lake Ontario, thus enormously enlarging the area of Buffalo, which has remained stationary for almost a hundred years. The first part of the St. Lawrence River work just above Montreal would, as Sir William Van Horne stated just before he died, make Montreal one of the really great ports of the world, and it seems certain that Toronto and Western Canada, as well as New York, would also be the gainers, to an undreamed-of extent, by the construction of so many new Pittsburghs, and the great saving in cost of bringing all the products of the farms to the market and increasing the number of such markets.

The New York Chamber of Commerce, in opposing this undertaking, did so on the ground that New York City paid 25 per cent. of the entire tax of the country; that she had a great harbor, had expended millions on the Barge Canal; and on

account of the great cost to the two Governments of canalizing the St. Lawrence River, which it was stated by their experts, would be from three to five million dollars.

The fallacy in these arguments seems to be:

First, if there were no farms, factories, villages, towns, or cities, etc., outside of New York City, there would be no New York City, and on the other hand, every dollar's worth of prosperity of any farms, factories, villages, towns, or cities in the New York State; in the United States; or even in Canada, results in a share of the profits reaching New York City, on the basis as stated by the Chamber of Commerce of 25 per cent. of the entire wealth of the U. S. A. On the other hand, the prosperity of New York City benefits every part of the continent.

On this assumption New York owns mines, farms, ranches, and all of the products thereof, although many of these products never come within hundreds or thousands of miles of New York City. Surely if all these articles, instead of being shipped to the consumers by the shortest and most economical routes, were to be shipped to New York City, unloaded, reloaded, and then shipped to their final destination, New York City would not only lose much of her present profits, but the cost of articles to the public in our country and many other parts of the world would be greatly increased.

Yet Buffalo thinks that such unloading and reloading would benefit Buffalo.

Many years ago, the President of a Bridge Company told me that if he lifted a steel plate six inches, it cost him money, and if he then changed his mind, and put it back in its original position without having accomplished any good purpose, he had wasted money. That means, of course, that all unnecessary handling should be eliminated. Elementary certainly, but often ignored.

Once more pardon me for saying that it is hoped that you gentlemen of Toronto will make these simple truths so obvious to the great public that they will be seen and believed

Always be constructors, not obstructors, as it seems impossible for anyone to excel in both lines. There is very little use in criticizing or pulling to pieces another men's plan unless you can submit something better.

At the present time ocean-going vessels can reach Montreal without the aid of any locks, the elevation of the water in the harbor of Montreal being about 24 feet above the standard mean level of the ocean.

It might be stated here as a matter of fact, that the rise and fall of the tide of the City of Quebec is about 20 feet or more.

Just above Montreal and below the Lachine Rapids, the river widens out into a big bay, in which ice often accumulates

and occasionally causes more or less serious floods in the City of Montreal. The first step of my project is to build a dam in the Lachine Rapids across Isle Heron, so as to raise the water to the high-water level of Lake St. Louis, which is 74 feet above the ocean level, then dredge the channel to the width of the St. Lawrence River at Montreal up to this dam. In reclaiming the rest of the land now covered by this bay, we could add 10 square miles for great manufacturing sites to the City of Montreal, which will be amply connected with every part of the city by adequate tunnels. Locks at the side of the dam would raise vessels 50 feet to Lake St. Louis. We could develop at this site one million horsepower. This is the project which the late Sir William Van Horne said would make Montreal one of the great ports of the world.

There are now a few water power companies at Cedar Rapids, Messina, etc.

Only three or four lifts between Lake St. Louis and Lake Ontario would be required, and these would give 3,000,000 horsepower more.

Then there is only a rise of two feet in the whole length of Lake Ontario, which is about 240 feet above sea-level. From Lake Ontario to Queenston, some seven miles, the Niagara River rises another two feet.

From Queenston to the base of the old Falls, there is a rise of 102 feet in the Niagara River, which we want to take advantage of by building a dam in the Lower Rapids in the Niagara River, which has a minimum flow of 220,000 cubic feet per second. This means that our dam would handle the entire minimum flow of the Lower River, giving us the maximum amount of power at the minimum of cost, or 2,000,000 horsepower.

By referring to the map, you will see that we can build the first half of this dam on Foster's Flats. That means that this part of the dam would be built on what is now dry land.

The base of the dam will extend some 35 feet below the present bed of the river, so it will then be possible by means of large openings in the bottom of the dam to divert the river through the dam away from its present channel.

It will be then a comparatively simple matter to finish the dam across the present channel of the river.

In so utilizing the 102 feet drop in the river we would not affect the old Falls nor the present power plants in any way whatever, but as the 2,000,000 horsepower we would develop would soon be inadequate to supply the needs of the people, we have a plan for any further diversion of water which may be permitted by the International treaty. This plan consists of extending Goat Island 1,000 feet or more up the river, and building inclined tunnels to take advantage of the 200-feet head. These tunnels would be about 3,500 feet long and would give

us the most economical method of developing water power resources of the upper Niagara River.

The reason for extending Goat Island is because the drop in the old Falls is 165 feet, and there is a further drop of about 50 feet within a mile above the Horse Shoe Falls.

When my project for a Niagara Falls Junior was first published, many laughed at the idea of ever using 2,000,000 horsepower in this location, so letters were written to many; with one very satisfactory reply, which was a very complete letter from the Hon. Samuel W. Rogers, who, in answer to my questions, summed up the sources of power then being utilized in New York State, which he gave as over 3,000,000 horsepower a year. He further stated that the normal rate of increase was ten per cent. or 300,000 a year. In other words, if half of our power were used in New York, and the other half in Canada, New York would only obtain one-third the amount of power she was then using, or enough to supply the normal increase in demand for three years.

The diagram shown on the screen, having Niagara Falls as the centre, and circles with the radius of 100, 200, 300, 400, and 500 miles from the Falls, was then published by me. This diagram shows by means of black streaks the present distribution of power from Niagara Falls.

This power is now transmitted, using 60,000 volts, to Syracuse, a distance of 160 miles, with the loss of less than ten per cent.; it is also distributed to the Detroit River with a similar loss by raising the voltage to 110,000, a distance of 250 miles.

By increasing this voltage again to 220,000, the distance of transmission could again be doubled. Therefore, it would be perfectly feasible to distribute Niagara Falls power within a radius of 500 miles.

Inside of this area, we find Quebec; Augusta, Maine; Richmond and Raleigh, in Virginia; all of Lake Michigan; and part of Lake Superior.

In other words, the 500-mile radius from Niagara Falls would include nineteen States of the Union and two Provinces of Canada, and inside of this area is 60 per cent. of the entire population of the United States and 80 per cent. of the entire population of Canada, all of which would then be within commercial reach of Niagara Falls power.

It would seem, therefore, very much better to use this power within 100 miles of the Falls, thereby following the example of the five pioneer companies, who staked their courage, money and experience in what was then an untried venture, and developed some 650,000 horsepower at the cost of $65,000,000, or $100 per horsepower.

In doing this they attracted private capital to the extent of $650,000,000, or ten times what they spent themselves, there-

by creating many new industries and enormously reducing the cost of many articles such as aluminum, carborundum, etc., which reduction in cost benefits nearly everybody on the continent.

If we developed 4,000,000 horsepower in the Niagara River and sell it at the site, we would create the greatest manufacturing district the world has yet seen. Whereas, if we tried to distribute it broadcast, the result would be, considering the Province of Ontario and the State of New York, as if a glass of water were thrown over this audience. That is, the proportion of people who would be slightly benefited by this power in the Province of Ontario and the State of New York would be in the same proportion as the number of you gentlement who would receive a few drops of this water.

It is very hard for people to realize the certain results of public ownership. We have tried public ownership of railroads, telephones, and many other things in this country, and Canada has also had much experience with similar results.

After public ownership of harbors in New Orleans, the city is begging private individuals to take hold again.

The same action has been taken by other municipalities in connection with gas works, etc.

This Province has made a great effort with public ownership of water power, and it was able to buy up much more power from the old companies at from $9 to $15 a horsepower, which would be absolutely impossible now, not only because the companies have learned the value of such power, but also because the cost of developing power by coal has increased so enormously.

Ontario Hydro then built transmission lines, distributing this power, selling much of it to consumers for one and one-half cent to three cents per kilowatt-hour.

It should be remembered that one and one-half cents kilowatt-hour is $100 a horsepower, and three cents kilowatt-hour is $200 a horsepower. So that the Government Commission which bought power at nine to fifteen dollars and borrowed millions of dollars for transmission lines was then able to sell power from $100 to $200.

Not having enough power to go around, the Hydro Commission then decided to build a canal of their own, the Chippawa-Queenston Canal, some twelve and three-quarter miles long. This was originally designed for 10,000 cubic feet per second, with a grade or loss of a head of eight feet.

The plans were subsequently changed to give a capacity of 16,000 cubic feet per second by increasing the depth so that the grade or loss of head would be 16 feet.

You gentlemen, of course, know that the so-called horsepower is the work done equivalent to lifting 33,000 pounds one foot per minute, or 550 pounds one foot per second.

You also know that on the basis of 80 per cent. efficiency

a cubic foot of water weighing sixty-two and one-half pounds and dropping 11 feet, will give 550 foot pounds per second, or one horsepower.

So we generally consider that one cubic foot of water dropping eleven feet per second is equivalent to one horsepower.

But when we sell a horsepower for $15 or $30, we mean 550 foot pounds per second for the entire year.

As the Chippawa-Queenston Canal will carry 16,000 cubic feet per second with a drop of 300 feet, the result would be less than 450,000 horsepower. But two-thirds of this power, or 300,000 horsepower could be obtained at a trifling expense, comparatively, by our short Goat Island Tunnels, so that the twelve and three-quarter mile canal will only give 150,000 horsepower per year more than could be obtained directly without this long canal.

The original estimates were something like $10,000,000. It is now conceded that the cost will be $55,000,000, and some claim that it will be much more. In fact, the probabilities are that, while the Chippawa-Queenston Canal will carry 16,000 feet per second, our dam would take care of the whole 220,000 cubic feet per second, and probably not cost much more at that.

Our Niagara Falls Junior, complete with power plants, etc., should not cost $100,000,000.

So if you will pardon the egotism, it seems obvious, that these projects will give the maximum amount of power at the minimum of cost.

On June 1, 1918, *The Scientific American* published an article by a former Engineer of Ontario Hydro in which he advocated the diversion of the whole flow of the Niagara River through the proposed Chippawa-Queenston canal by means of a series of canals, four being shown on the plan, of which one is now nearing completion. It was advocated in this article that a dam built above the Falls would, of course, necessitate preventing of any ice leaving Lake Erie. They, therefore, advocated an ice boom in Buffalo.

It would certainly take "some" dam to hold back all of the ice in Lake Erie, for there is a break-water at Buffalo now standing some 15 to 20 feet above the water in summer which the ice and waves pass to a height of 15 to 20 feet above the top. As Lake Erie is subject to violent storms, it would seem impossible to hold back the ice without disastrous results, flooding much country, etc. But even if it were possible to so hold it back, it would absolutely interfere with the navigation for several months every spring, resulting in cold and late springs every year.

It seems to us that our Niagara Falls Junior affords the only method of controlling the ice in the Lower River, for we would have a minimum depth of water back of our dam of 135 feet,

a minimum flow of 220,000 cubic feet per second and a restricted channel. As our dam will have very flat slopes both up and down stream, there would be nothing to stop the ice on the up-stream side, and the ice would have no drop after passing over the crest, as it would simply slide off into the deep water.

On the other hand, it seems that any and every other project proposed would surely result in a catastrophe, for there is barely enough water now passing over the rocks in the Rapids to carry the ice away, and even if ten per cent. or twenty per cent. of the water were diverted from the Rapids, it would seem to make the danger of an ice jam almost certain.

An engineer should not make such a drastic statement as this without some proof. So we might cite a case of some dozen years ago, when a change in the wind at Buffalo held the water back for a few minutes, resulting in an ice jam in the Lower Rapids, which lasted eight hours. Before the jam broke it had backed the water up at least 60 feet in height until it did considerable damage to the old power plants, and when the jam broke it carried out absolutely everything in the River below, wharfs, buildings, trees, shrubs, etc. The only reason that the damage did not cause a greater financial loss was because there was nothing left to destroy.

As an engineer should not stop at one example, we might go back say 12,000,000 years,—perhaps a few seconds more or less,—when something caused a jam in the Niagara River, and made it turn a right-angle, thereby forming the Whirlpool, cutting the brand new channel out of bed-rock. And it seems more than probable that nothing but an ice jam could divert this 220,000 cubic feet per second, and make it cut a new channel out of bed-rock. Surely this dam could not have been built by beavers, although a friend of mine has told me that there is a dam in Massachusetts which he claimed was built entirely by beavers from one end to another. My friend doubted this statement, but was positively assured that it was so.

He then said all right, he always knew the beaver was a very smart animal, but it was the first time on record he ever heard of a beaver that had foresight enough to put a six-inch cast iron drain-pipe in its dam.

While it seems to us that it would be probably unsafe to divert even ten per cent. of water from the Lower Rapids, other engineers have recommended 40 per cent. to 50 per cent. diversions, which seems very extraordinary reasoning, as it sounds like a statement that while the whole flow is not sufficient, half the flow might be. But in this connection they claim that they will have controlling devices in Buffalo which would wipe out any jam that might occur, by holding back the water, so that the flow could suddenly be increased from 200 to 300 thousand

cubic feet per second.

In the first place, it would seem very hard to hold back the water without holding back more ice, and it would be more apt to hold back the ice and let the water pass through, making a worse condition than ever. But if the flow were suddenly increased 50 per cent. in the Niagara River, it would make it exceedingly dangerous, to say the least, for anything that might be in the river.

There is another argument that has hard work penetrating my skull, possibly owing to my Scotch ancestry. It is that the poor old Horse Shoe Falls are being destroyed by the great rush of water, and that the way to protect these beautiful Falls from further destruction is to prevent so much water passing over them.

It has always seemed to me that ice and logs do more damage than water, and that if the same amount of ice and logs were carried over by half the amount of water that the damage might be much greater. The question was asked me, what right or reason there was for the statement that the ice would do more damage than the water. But surely any of us would prefer to put our heads under a flow of water than of ice cakes, as we are not like the colored gentleman in New York who recently allowed a mule to kick him on the head, thereby breaking the leg of the mule.

A minister who prepared me for confirmation some forty years ago, told me a story to illustrate his point, which is well worth remembering. The point was that if you cannot do a thing in the right way, you had better not do it at all. The case cited happened off Yonge Street wharf in Toronto the preceding week, when a man saw another man struggling in the water. After yelling, "Help! help! Why does not somebody save him!" and finding nobody to do so, he decided that he would have to make the effort himself. So he seized a large log and threw it to the poor chap in the water, hitting him squarely on the head and thereby knocking his brains out. As the minister properly remarked, it would have been better if he had not tried to help.

Now while we have got all the possibilities of building up the greatest industrial centres in the world, surely no mistake should be made at this time.

If this stupendous work were undertaken by Government ownership in the old sense of the word, God help the countries! On the other hand it is absolutely inconceivable that the two Governments would give concessions to any combination of individuals, giving them private ownership, in the old sense of the word, of rights which might be equivalent to 80,000,000 tons of coal a year, or $800,000,000 a year, and to let this work to individuals on a percentage basis, would be the same as Government ownership. So our proposition is that the two Govern-

ments get together and give us the rights to canalize the St. Lawrence River and develop the water power in both the rivers under strict Government supervision as to plans, construction, operation, selling-price of power, amount of taxes to be paid, and our remuneration, on the basis that if it costs us say $15 per horsepower, our remuneration would be so much; if more than $15, our remuneration would be less; but for every dollar we save below $15, we would get the lion's share. That means that we would have every incentive of a private ownership to go ahead and do our————that is to say, build the most economical dam.

While on the question of price, it might be stated that it does not make any difference what price power is sold for, it will always be worth just exactly what it cost to develop it by coal.

Now the cheapest power developed by coal in New York city before the war, was by the New York Edison and New York Interborough, and it cost them on the average of $32.19 a horsepower to develop such electricity by coal. That means that $70 or $80 a horsepower now in the States and far more in Canada.

As a matter of fact, it was testified before the Federal Power Commission in Washington on January 25th, that individuals who have to use coal are now paying $100 a horsepower at Niagara Falls. And the Canadian Manufacturers' Association told me it is now costing over $90 a horsepower in the City of Toronto. If therefore pet consumers get power from $9, $15, $20, $25, $30 a horsepower, they will have a very unfair advantage over their competitors who have to pay $90 or $100. Now our proposition is that part of this difference be made up by heavy taxes. The Ontario Hydro Commission is now protesting against a tax of $2 per kilowatt-hour, which is less than one thirty-second of a cent per kilowatt-hour. But if the Government were to tax us $30 a horsepower it would be less than one-half of a cent per kilowatt-hour, and if it cost us $15 to develop the power, the consumer would only have to pay $45 a horsepower, and even then the users of our power would get it for half of what it costs their competitors, who would have to use coal. And if this tax were paid on 6,000,000 horsepower a year, it would mean that a tax of $180,000,000 could be divided between these two countries.

The cost of canalizing the St. Lawrence and developing the water power of both rivers would be about one billion dollars. A tax of $30 per horsepower would be 18 per cent. of the total cost. In addition the countries would have the benefit of cheap power and the saving of 80,000,000 tons of coal a year, and vast industries constructed to the great benefit of practically everybody in the United States and Canada, as well as almost every part of the world.

METHODS THAT MAKE FOR SUCCESS IN THE APPLICATION OF COLLEGE THEORY TO WORKS PRACTICE *

By Harold J. Roast, F.C.S.

AFTER accepting the invitation of your Secretary to come to Toronto to address you, I was somewhat at a loss to know what subject to choose.

During the last eighteen years I have frequently met with the College graduate as he was leaving his Alma Mater and coming into contact for the first time with commercial life. As a result I have been much impressed by the difficulty the graduate often experiences in endeavoring to make that progress that might reasonably be expected from the knowledge gained during university work.

While we realize that the college curriculum can only lay a broad basis upon which to build, rather than to erect the finished edifice, nevertheless it is to be expected that the erection of a permanent structure in the commercial world should be decidedly hastened by the systematic training undergone.

It frequently happens, however, that much disappointment is experienced at the slowness of the progress made, or even, in some cases, at the retrograde action which develops. The fact that later on the worker finally adjusts himself to his environment does not compensate for the time lost in the interval. These facts having come to my attention repeatedly, prompted me to make the subject of my address to you as advertised, namely, "Methods that make for success in the application of college theory to works practice."

Every student as he enters the University wishes for success in his examinations and for the final success of his degree. On leaving 'Varsity and entering upon his life work, he realizes that still more momentous possibilities await achievement, and feels instinctively, to some extent at least, the greatness of those forces with which he will have to cope.

Are the requisites for success in the University life the same as those which bring reward in the commercial world?

The answer is in part affirmative. Earnestness, interest, application, and perseverance, are common to both. One may acquire knowledge in the course of college training, however, by pursuing an isolated course, being even boorish to one's confreres, and unpunctual in one's appointments. The business world, on the other hand, demands of its really successful pupils, that they cultivate the society of others, that they develop a courteous personality, and be punctual in all their engagements. Tact and diplomacy without which one can makeshift to get through college are vital factors in successfully solving the commercial equation.

*Given before the Chemical Club on January 28th, 1921.

In these days when the scientific man is being recognized as never before, it is vitally necessary that he take care not to limit his sphere of usefulness by want of attention to basic principles which stand out clearly as fundamentals in the commercial world.

The chemical graduate has generally two avenues open to him through which he can commence his career. Either that of instituting chemical control or joining the chemical staff of some company as a more or less routine assistant for the time being.

Let me deal in the first place with that type of graduate, who is fitted to fill a responsible position, and has under consideration the entrance into the activities of a large company. Let us suppose further that he is a chemist seeking an opportunity to develop the chemical side of such an institution that has operated for many years without chemical assistance. The most important point in such a case is to get the right relationship established between himself and the company.

Right Relationship

If the company consists, as most companies do, of many departments, each with its own manager, it is very advisable that the chemist be responsible to some one who is a neutral party as to these departments, such for instance as the General Manager, Managing Director, or Board of Directors.

Such a relationship will enable him to serve any or all departments freely and to avoid much of that trouble that arises out of inter-departmental jealousy. Again it leaves the man free to draw attention to possible waste in *all* departments, instead of feeling that if he remark on this or that weakness in that particular department to whom he is responsible, he runs the risk of antagonizing his immediate chief, with the possibility of losing his position.

Too much stress can hardly be laid upon the importance of "Right Relationship." It is so much easier to arrange such a matter before entering a concern, rather than to endeavor to have a change made after one has become part of the system. In the latter case it is often impossible to suggest the change without it being thought that personal differences are at the bottom of the request. In the former case one acts with presumably no knowledge of the personnel of the staff or the personalities involved, being actuated only by a desire to serve the company in the most efficient manner.

Attitude of Mind

Having established the right relationship, probably the next most important thing is the attitude of mind of the worker. Ofttimes a wrong impression is created by the graduate, because he takes a didactic rather than a receptive attitude towards those who are actively engaged in carrying on the operations of the company. This means that an impression is created

that the chemist has come to teach the men and managers how to run their business, which business has probably been conducted along more or less successful lines for many years. Naturally this attitude is resented, and an atmosphere which is not conducive to co-operation is created.

If, on the other hand, the chemist approaches his work in the company in a receptive state of mind, being willing rather to learn from those already in the business, that which they may have to teach him, rather than to undertake to teach them his viewpoints before he has a solid basis for them, a spirit of tolerance is created which later on may develop into friendly co-operation.

Tact

What has been said of the attitude of mind is closely associated with the next most important requisite for the successful development of chemical or any other work, namely *tact.* This small word "tact" is one of the most important in our language, for the lack of it many a forceful and able worker has made no progress, and in place of building up an organization by the strength of his personality has, by that very strength itself disintegrated the organization that already existed. Tact might be described as the realization of the other man's viewpoint, and a readiness to so represent your suggestions as to have the other man feel that they really are his own. Tact also involves an appreciation of that old world courtesy which is given alike to master and man.

Remember that it is very essential that you study men as well as material; you will have to work with both.

It may be well at this stage to leave generalities and to take up the active life of our chemical graduate as he starts in in real earnest to apply his technical knowledge to the works practice.

Study of Operations

Bearing in mind the receptive attitude already referred to, a careful study of the operations of the plant is the natural preliminary to devising a routine technical control. In such a study it is well to go slowly and acquaint oneself with the difficulties and arduousness of the various operations involved. The making of such a study should include the getting down to the plant as early as the first workman and remaining until the last man leaves, or, if the operation is continuous, then remaining one entire twenty-four hours, as well as repeated visits on other days during reasonable hours. Opportunity should be made to try out any specially tedious work in order that a more accurate appreciation may be had of the effect of the labor involved upon the workman. If the foregoing plan be adopted then the securing of really accurate data should be readily accomplished. Many an improvement suggested has proved futile, owing to the

insufficiency or inaccuracy of the data upon which it was based.

Let us now assume that the chemist has noticed a stage in the manufacture that he thinks is capable of improvement, and that he has an idea as to the nature of this improvement. Before devoting much time to the working out of the detail one is well advised to make as thorough an investigation of the bibliography of the subject as can be. In many cases it will be found that the ideas which have been conceived in a broad way have been already worked out in minute detail by other authorities. A study of the literature will frequently enable the graduate to avoid many pitfalls, nor must it be thought to detract from the credit due him.

Improvement Decided Upon —Bibliography

In the commercial world it is that which has been accomplished in the way of reduction in cost or increase in capacity that is rewarded without regard to its originality. One who digs out past accomplishments and applies them to to-day's problems is at least *as* useful as one who insists in advancing only original ideas.

Having worked out the new improvement in theory, it is very desirable that it be tried out in practice in the works in as quiet and unassuming a way as possible. For example, it is preferable to work through a works foreman rather than through a department manager. If the experiment is a success time enough to notify those in authority of the improvement, while if it gives evidence of weakness the less said about it the better. In the satisfactory event of the idea proving itself both practical and economical, the next thing is to present it to the chief or chiefs in the most favorable form. At this stage it is well to remember the saying of the wise man of old time, "Oh, that mine enemy would write a book." Too much haste in rushing in written reports and too great a degree of definition and detail therein will often leave one open to criticism and flank attacks that might never develop if the old saying of "least said soonest mended" were heeded. If a verbal report will meet the case keep the written data for some later occasion, such as the annual report, which will then be able to go with safety into greater detail because of the longer experience to which the improvement has been submitted. Frequently, however, a written report is called for, in which case due regard should be had to the motto, "Brevity is the soul of wit," using the last word in its true sense of wisdom rather than humor.

Presentation of Idea

State only certainties to the management as such, being careful to show the probabilities as possibilities, and leaving out the possibilities altogether.

Clear and concise arrangement of data is, of course, a re-

quisite, and a free use of tabulatory statements is to be recommended, as also a liberal use of marginal subsections such as "Present Operation," "Proposed Changes," "Increase of Production," "Saving Effected," "Recommendations," etc.

Spirit of Report

The whole spirit of the report should be that of showing benefit to the department involved, with a minimum reference to the part played by the chemist himself. In any *final* report the effect of any improvement should be reduced to dollars and cents. This is the main appeal to any management, and fortunate is that executive who can clearly show a balance on the right side, even after the financial statistician has checked over the figures.

Handling of Labor

As our graduate develops with the company he will possibly be called upon to take some active part in the direction of the labor which is concerned with the improvements he has introduced. In the general issuing of instructions to the men for whose operations you are responsible, endeavor, of course, to give only the most efficient order in each case. If, however, an order has been given, do not change it because a somewhat better way has occurred to you immediately afterwards. To acquire a reputation for not knowing one's own mind is a sad handicap in handling men. I do not want to be misunderstood in this connection, nor to convey the impression that one should be obstinate in allowing a considerable loss of efficiency to follow an unsuitable order rather than to correct it. Nevertheless, I have known many scientific men who, as a direct result of their training in the search after truth, are almost always modifying their orders because of a sudden possible improvement that occurs to them, with the result that the impression is created, particularly in the mind of the ordinary laborer, that "the boss doesn't know what he is talking about."

Routine Chemist

So far we have taken up the case of the chemical graduate who enters a company as its first chemist. Many, however, start their professional career by becoming one of a number of routine laboratory chemists. Here, again, the same principles of receptiveness and tactfulness apply. To do accurately and rapidly the work entrusted to him is the first consideration, but no opportunity should be missed that offers a chance of becoming acquainted with the manufacturing end of the company's activities. Such opportunity frequently comes in connection with the taking of samples throughout the works. I have known of more than one case, however, where the routine chemist did not care to leave the accustomed atmosphere of the laboratory to go into, it may be, the rougher and, ofttimes, the dirtier, surroundings in the works. Such a man misses the works inspiration, or power of

suggestion that will make itself felt to any trained observer.

Go to the factory for your suggestions and return to laboratory or office to develop them.

The routine chemist who finds or makes the opportunity of getting an insight into works procedure will not always remain a routine analyist, but will assuredly be called upon for work in a wider field.

Do not think that I wish to belittle Routine Analytical Chemistry. This is the watchdog that safeguards the investment of capital spent in raw material, and of reputation concerning the finished product. The chemical industries and, in a measure, all industries, owe much to that type of man who consistently and painstakingly, day after day, checks up the numerous stages of manufacture, who draws attention to dangers ahead, and, often, especially in the case of raw materials, prevents them altogether. Nevertheless, Analytical Chemistry provides after all but the bricks and mortar for use in the working out of problems by dint of careful logical reasoning based thereon.

At the risk of being guilty of going into too much detail I should like to give my ideas in regard to some of the things needing the attention of the works chemist.

Standards

One of the first of these is the preparation of "laboratory standards." That is to say, a collection of those raw materials and finished products with which the particular works is concerned, and the composition of which needs to be accurately known. To obtain such standards it is necessary to have them analyzed by other chemists, and that these referees agree closely. It is found that the best people to call in on such work are other works chemists engaged in similar lines to one's own. The man who has his laboratory fitted up for a limited and special line of work, and whose daily business it is to make any given analysis, is likely to have acquired a far greater degree of accuracy than is the general consulting chemist, whose efforts are perforce spread over a great variety of problems, resulting in a less concentrated and detailed knowledge of any particular one. Having obtained such a series of standards as a result of the reports of works chemists, our chemist will be well advised to send samples of these out to such well-known consulting chemists as it might reasonably be expected would be called in by the company in case of disagreement between them and their customers. Very surprising results may develop, but if the matter be persisted in, the chemist will in the end have reliable information as to whom he can appeal to as arbitrator in time of need, either his own or his company's.

Another detail which I have found worthy of consideration

is the use, rather than the abuse of, the laboratory note-book.

Use of Laboratory Note-book

The purpose of such a book is obviously to record the notes needed during laboratory work, but so often one finds the young chemist entering only the *final* figures of his experiments or analyses. This results in many an error escaping discovery, such as the recording of the wrong number of cubic centimetres used in titrations or the wrong factor applied to a gravimetric estimation. For example, the analysis having been reported, it may be queried, whereupon such questions as: "How many cubic centimetres were used?" "What was the actual weight of precipitate obtained?" "What figures were used in the factor calculation?" "What weight of substance was actually taken for analysis?" etc., etc., naturally occur. If the working notes have been jotted down on pads they are by that time lost, and with them has gone all hope of checking up the work. If, on the other hand, the laboratory note-book has been the recipient of every figure and sketch whatsoever then it will often be to furnish the clue to errors that would otherwise be undiscoverable. Such a system should be followed, even at the expense of an untidy note-book.

Methods of Analysis

In regard to methods of analysis for routine control, bear in mind that those operations that permit of the completing of the analysis in the original container have much to recommend them. The simpler the methods the better, as also are those which permit of a wide latitude in regard to the amount present of that element or compound whose percentage is to be determined.

Let us now turn our attention to matters that affect both the chemical adviser and the laboratory chemist. Here we may well bear in mind that every chemical assistant should be so preparing himself, that he may eventually become a Chemical Director.

Methods of Attack of Works Problems

Works chemists and works problems should be inseparable. Let us therefore consider what is the best method by which to attack these problems. There are two ways, at least, namely the application of scientific theory as such, the other a matter of trial and error, which latter may or may not be, conducted along scientific lines. The former results from consideration of the problem in the office and the laboratory, the other by means of a works study. The most efficient method to pursue is a combination of both systems. Too great a detailed study of the purely scientific is apt to lead to the recommendation of a line of action that cannot be applied under the conditions pertaining in the factory. On the other hand, the spending of day after day in the works, cou-

pled with a neglect of reading up on the matter, means frequently that the observer gets so bothered and worried by the unsatisfactory condition of things that he is not in the frame of mind to coolly size up the situation, or to develop some possible clue to its fullest extent. One needs to take some days or hours off, depending upon the magnitude of the problem, in which to make all the logical deductions possible from the facts known.

A common error in attempting to work out a problem is to vary several factors at once, such as time, temperature, dilution, composition or what not, whereas the reasonable and more certain procedure is to never vary more than one factor at a time, This may or may not take longer, but it is undoubtedly more certain. It may help the chemist or chemical engineer to appreciate the foregoing if he imagines for the time being, that he is blind, that he has the knowledge of chemistry obtained by his university training, and is facing a factory problem, having to depend on the data supplied by others. Under such circumstances what data would he call for? Has this data been provided?

It has been frequently borne in on me that many a difficulty, chemical and otherwise, can be solved from the office desk by logical deductions from a few, it may be, very simple facts. This side of the works chemist's brain needs constant development, nor will the plant be found wanting in the supplying of material upon which to work.

Library and Periodicals

Reference was made at the beginning of this address to the need of looking up the bibliography of the subject in hand. This pre-supposes either a library or access to one. Associated with this is the subscribing to current periodicals. To get the most out of monthly or bi-monthly papers, it is desirable to subscribe for both the individual numbers and the indexed annual volume. The former keep one in touch with the latest developments of one's industry and may be dissected for filing purposes, and the latter form a record which is handier for reference. Although strictly scientific reading matter should not be neglected, yet considerable attention should be given to trade journals. The questions and answers which form a special section of such publications frequently contain much sound advice, and when coupled with scientific training may be used to great advantage.

Indexing of Analyses

The making of proper provision for filing and indexing books and papers is naturally most important. In this connection one should bear in mind the value of the routine analyses. These will often give valuable information as to the variation in the purity of trade materials, the characteristic impurities of each source of the same kind of material, etc., so that the chemist

is able, after studying a long series of such figures, to state what is the source of some given lot by the analysis alone. The acquisition of such knowledge may be of the greatest use in chemico-legal work, which class of work will come to most chemists sooner or later. To get the most out of the routine work referred to means that all analyses must be card-indexed as to material and cross-indexed as to name of seller, etc. The simpler the system used the better; the main thing is to see that once such an indexing arrangement is started it is kept up-to-date.

If one admits the *raison d' etre* of a library to be its direct and practical utility in helping in the solution of works problems, then one must pay serious attention to its development.

Cultivation of Acquaintances

If, however, the collection of books and written material is beneficial, how much more the development of a friendly relationship with one's *confreres*, both in the chemical and commercial world. One of the easiest ways of starting a *human reference library* is to join the leading organizations connected with your profession and the business in which your company is engaged. Further, if you are to use your membership to the best advantage, you must be willing to take an active and constructional part in their activities, nor need you count time expended in such work as purely philanthropic, for, as has been suggested, real and tangible benefits will accrue to yourself.

I would take the liberty of urging you to concentrate on the local and Canadian organizations first, for it is from these that your greatest help should come, and to whom you owe your first support.

Conventions

Most organizations, particularly here and in the United States, make a strong feature of conventions. In this they are, in my opinion, wise, for rightly conducted and entered into in the right spirit, participation in such gatherings is undoubtedly a grand incentive. That the benefits of such meetings to those who attend them are real is evidenced by the encouragement given them by an ever-increasing number of companies, both large and small. One goes to a convention, not so much to see exhibits as to obtain ideas from the experts who are in attendance—*not primarily to hear papers, but to meet men.*

It must, of course, be conceded that in order to derive benefits from others we must be equally willing to bestow such knowledge as we ourselves possess.

Purchasing of Machinery

A visit to a convention generally results in one's being tempted to purchase or recommend the purchase of at least one piece of works machinery. In this connection, it is well to heed the warning, "Go slowly." Of course, the chemist is often called upon by his company to recommend new equipment for

the works. It is noteworthy that in many cases, purchasing agents, superintendents and others frequently order machinery that fails miserably to meet the demands made upon it. Careful attention to the following points will reduce the chances of error:

In the first place get accurate data as to the amount of material to be treated in a given time.

Then remember that two machines doing the work of one may often be best on account of the provision this makes for continuous operation in the event of the breakdown of either.

Bear in mind that first cost is not the only criterion and that the operating cost must include not only power and labor, but also repairs.

Purchase of Equipment

If at all possible, and even at considerable expense, have a working sample of the product you intend treating tested out by the makers of the equipment in the machine the purchase of which is contemplated. Attention to this point alone will save many a misunderstanding between the supplier and the purchaser.

In the recommendation of new equipment it is an advantage to give reasons in terms of earning power and, in your estimate of the cost, provide for a good article with all its necessary adjuncts and with special emphasis on suitable housing accommodation, working space and cost of upkeep.

Many, or in fact, most of the suggestions of this paper, may seem self-evident and hackneyed, yet it has been my experience that such matters are often overlooked by the untried chemist or engineer and even for that matter by those whose length of service should warrant greater efficiency.

As the chemical graduate develops so will he probably tend to more executive and less detailed work. Here one of his first duties is to develop a sense of responsibility in others. A man's usefulness depends not so much in what he can accomplish by his own efforts as it does on the extent to which he can develop in others the technical or executive ability and thus be the prime mover of many productive workers, rather than of himself alone.

POWER-PLANT INSTRUMENTS AND METERS *

N opening his address, Mr. Bailey pointed out that the metering of electricity was a comparatively simple matter compared with the metering of fluids. Fluid meters had been developed only comparatively recently. The reasons for their development are twofold. In the first place, great economy was to be effected by having immediately at hand exact knowledge of the conditions prevailing in all parts of the power-plant. In the second place there was competition between the manufacturers of power-plant instruments which furthered their development.

Venturi meters have long been used by the hydraulic engineer, and were first used in the steam power-plant for measuring feed-water. Later, rate meters were devised for masuring high pressure and exhaust steam, gases, oil, etc., also stoker speed.

Electrical energy is developed in the great centres of population by large steam turbines requiring immense amounts of steam. It takes one to two hours to bring some turbines up to speed. This must be done very gradually. It is therefore necessary that accurate means be provided for determining this speed, in order that the speeding-up may take place without fluctuation. The speaker said that in his opinion there were more turbine failures than the average engineer was aware of. The manufacturer blamed the operator for not taking proper precautions in bringing up to speed. The operator blamed the manufacturer for poor turbine design.

Mr. Bailey then spoke briefly of the average power-plant test. Generally it was of but a few hours' duration and yielded results of no great value. The efficiency obtained over months of operation was the important factor to be considered. The average boiler test was usually like a horse race. All conditions were made as favorable as possible for the test or for the race, and the maximum output and highest efficiency found for that particular period. Such results may be all right, and may have their place, but all-year-round efficiency was of greater importance.

Mr. Bailey has for some years focused his attention on combustion, paying particular attention to the condition of the fire. It is here, he said, that the greatest financial losses of the power plant occur. Coal is money and through the inefficient burning of coal great loss is incurred which might otherwise be avoided.

Mr. Bailey explained certain principles upon which meters depended for their usefulness. Heat lost up the chimney varied, depending upon the amount of air burned. Too little air caused losses through the formation of CO, resulting from unburned gases and poor combustion. On the other hand, an excess amount of air also caused losses due to the heat absorbed by this unnecessary air. There is therefore a happy medium, giving

*Synopsis of address by E. G. Bailey, President of the Bailey Meter Co., Cleveland, before the M. and E. Club, February 18th, 1921.

minimum chimney losses. It must of necessity be determined for each boiler. Hence we may say that for each particular boiler installation there is a certain weight of coal to be burned with a certain weight of air in order to produce the best results. When this amount of air combines with the available hydrogen and carbon in the fuel, a definite amount of heat is produced. We may therefore speak of the heat produced per pound of air. When this heat is produced and properly absorbed by an efficient boiler, a certain amount of steam is provided. We may, therefore, rate the amount of steam produced to the amount of air used for the combustion, and so obtain a very reliable indication of the efficiency of the combustion taking place in the furnace.

This relation can be visualized on a meter by arranging two pens, the one recording steam flow, the other recording air flow. The steam flow can be measured by inserting an orifice in the steam pipe and arranging a suitable differential pressure gauge. The air flow can be measured also by a differential pressure gauge, the boiler passes acting the same as an orifice.

When the relation between the air flow and the steam flow is correct, the air flow reading is 1.00. For an excess of air the reading would be greater than 1.00 This would mean that there were holes in the fire-bed or that the fire was too thin. This condition can be remedied by the fireman, so that the air will come in proper contact with the coal and produce its full quota of heat. On the other hand, for too little air the reading would be less than 1.00 and would mean that the fire was too thick, and that there was a loss due to unburned gases.

It is therefore up to the fireman to see that the dampers are so manipulated as to burn the right quantity of air for a given steam output.

A meter has also been devised to show the rate of stoker feed, and, hence, the rate of coal consumption. This, of course, should synchronize with the steam flow and the flow of air.

Heard in Machine Design.

Shortt—Are you using an English Channel, Staff?

Stafford—No, a Behring Strait. (bearing straight.)

Turn on the H_2O.

PROUD, ALOOF, WHITE COAL WILL NOT OUST MEEK GAS *

Feeling Grows that Electrical Energy Should be Used for Power Purposes Only—The Gas Industry Making Great Strides in Competition with its Electrical Brother.

THAT gas is only lately coming into its own, goes without saying with those who know the situation, and a few extracts from reports of eminent authorities may be of interest at this time in this connection.

That gas for illuminating purposes has not as promising a future as electricity is granted, but still there are thousands, and hundreds of thousands of homes throughout the country that will be for a long time to come the best users of gas for this purpose, because of the fact that there is not yet, and will not be for some time, if ever, sufficient electrical energy available to supply the many local requirements.

The gas industry has made remarkable strides during the past ten years. It is gaining steadily notwithstanding the tremendous publicity given to the development of its competitor—electrical energy— and to the wonderful extension of the Hydro Electric Power Commission's work in Ontario. Men who know are beginning to realize that the electrical power plants now in operation, and contemplated, will never be able to supply the ultimate demand that will be made for power in Ontario alone. Electricity for baking, ironing, and other purposes, is no longer an experiment, but would be an admitted success as far as doing the work is concerned, if it were not for the fact that the use of electricity, for such purposes is nothing short of a national crime, and especially will this be so in the future, when one considers the same energy will do 25, 50 and in some cases 100 per cent. more useful work if used as a motive power. Many people are looking forward to the days when electricity will supplant the use of coal and gas for fuels in the heating of their homes, and for doing many other heating operations. But, using the words of a well-known gentleman in the person of Mr. Arthur V. White, Consulting Engineer of the Commission of Conservation, that "The sooner the public mind is disabused of the idea that, as a heating agent, electrical energy can be made an adequate substitute for coal for the thousands of Canadian homes, the better it will be for it." He states that its economical use is in the direction of the development of power. In referring to this same gentleman, an editorial published in the April 1918 *Industrial Canada*, on electrical heating, states that, "It will doubtless come as a surprise to many that in the opinion of so able an engineer as

*Being a digest of a Lecture given by G. W. ALLEN, Educational Director of the Consumers' Gas Co., of Toronto, delivered before the Metallurgical and Mining Club, University of Toronto, January 28th, 1921.

Mr. Arthur V. White, of the Conservation Commission, the application of electrical energy in the production of heat, is a very much exaggerated possibility. We have for some time, had a sort of pleasing feeling that, sooner or later means would be devised for the economic utilization of the electric current in heating houses.

"The fear that the coal supply would be exhausted within a certain number of years was offset by the belief that long before that time we would have become quite independent of coal. Mr. White, of course, does not say that means will not be found to produce a suitable substitute for coal, but the point is that we should not rely on "our water powers to do the trick." There will be adequate for power purposes, but not for heating purposes, and until some other source of electrical energy is discovered, we must do our best with the present arrangements."

At one of the meetings of the Civil Engineers held in Toronto in 1918, it was quite clearly shown from a digest made of the papers read at those meetings, and from the discussion that took place between the Engineers representing every branch of the fuel industry, that electricity was doing the country a great service whenever it was utilized for power purposes, but when used as a heating agent, was doing the country a national injustice.

In recent years there have been many meetings that tended to give the gas men on the other hand great encouragement as to the future of their industry. That gas will play a very important part in the future of this and other countries has been clearly proven, of late, especially when we review the great progress made in modern carbonization processes.

To show what an important place the gas industry holds in the country's economic problems, would say, that in the U. S. alone, there have been constructed during the past few years, over 5,000 coke oven plants producing high-class coke for metallurgical, foundry and domestic purposes, and incidentally, large quantities of gas, and other by-products, the total value of which reached, I understand, for last year, to the enormous sum of $300,000,000.

It is being realized more than ever, that coals of all kinds should be put through a carbonization process, thereby obtaining a high degree of efficiency in the return of valuable constituents, rather than wasting a high percentage of its efficiency by burning or consuming same in its raw state directly under boilers and other heating equipment. And so with utilizing electrical energy as a heat producer we find that great losses were sustained by transforming the electrical energy into heating energy, and this is very strikingly manifested when one considers the great amount of energy required to develop a comparatively small amount of heat on the B.T.U. basis per K.W.H.

A simple illustration of this is shown by the amount of energy it takes to operate an ordinary 6 lb. electric iron, commonly used in the homes of the people. One of these irons requires as much energy to operate as would be required to light up twenty-four 25-watt tungsten lamps, or sufficient to run approximately 16 sewing-machines simultaneously. My belief is that it would be far better to have this energy devoted to power uses only, than to waste it in heat-producing appliances. Again, if all possible energy was developed by harnessing every waterfall in Ontario, and utilized for heating purposes only, there would not be enough heat generated to warm even a small percentage of the homes, say in Western Ontario.

There is great demand for electric current for power purposes, and as I understand it, in normal times, everyone of the 247 odd municipalities in Western Ontario, who depend upon Hydro Electric power, are considerably short of the amount required to take care of ordinary demands, let alone the demand that will be created for power within the next ten years. Then again, there is the Hydro radial development schemes which will require a large amount of power for operation purposes, and when one considers the present shortage coupled with the demand that will be made in the near future, it can hardly be expected that the energy to be developed at Niagara Falls through the Chippawa Creek scheme, or other developments, can take care of the ultimate demand.

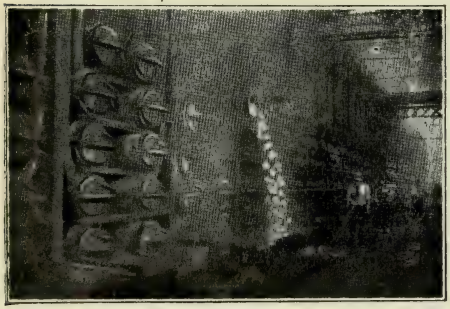
Personally, I believe the steam railroads in Western Ontario should be electrified, and if such is to happen, we will require all the energy we can possibly gather together to take care of such loads, let alone that also required in other industries. The changing over of the steam railroads to electric power will, on the other hand, release large quantities of coal for use in gas development in the future, and although most of such coals are not considered good for coking purposes, still when properly combined with good coking coals, answers the purpose for gas, coke and by-product developments admirably.

It is not the present time I am mainly considering, but the future development of both gas and electricity in this country, and anything that can be done to place the gas and electrical industries on an efficiency basis, will be well rewarded.

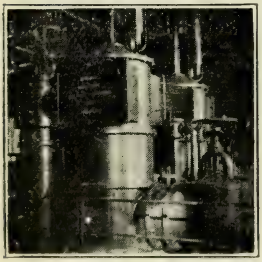
To give you an example of the gas development and progress, even in the midst of the cheapest electrical competition, almost in the world, I would point to the work developed by the Consumers' Gas Co., of Toronto. At the beginning of the Toronto Hydro Electric development work, this company, although at that time it had been 61 years in business, decided to establish a New Business Department for the purpose of educating the people on how to get the greatest use out of its gas in return for the amount of money expended. It felt that if the

Modern Coal Gas Benches, Showing Mouth-pieces of Horizontal Retorts. Coal Charging Machine Also Shown.

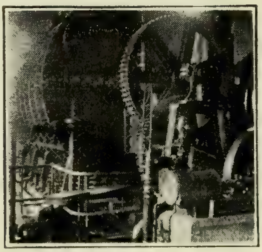
Old Method of Placing Coal in Retorts in Large Gas Works.



Coke Discharging from Retort. Pushed Out From Other Side by Discharging Machine

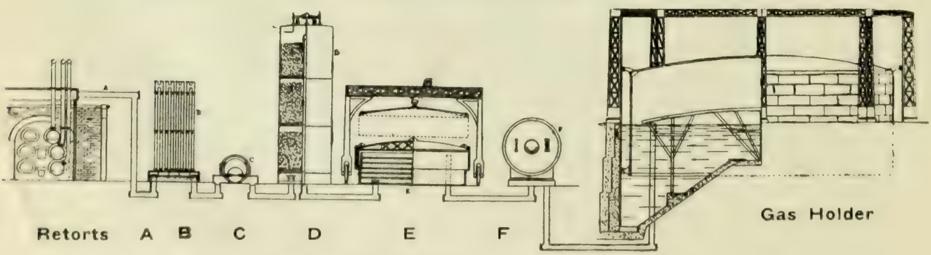


Pressure Regulating House



Machines for Washing and Scrubbing the Gas

Tar Removing Apparatuss



A Sectional Drawing of Coal Gas Works

people understood the proper use of gas, and if the Company taught them how to use it more efficiently, it would be an effort worth while. That was ten years ago, and the Company had at that time approximately 55,000 consumers, but which, in the face of the competition mentioned, has increased this number to 123,000 at the present moment—"more consumers of gas, I understand, than the city itself has water customers." The output of gas has also increased from an average of around five million cubic feet daily to nearly fifteen million cubic feet daily, and on some of the cold days of the winter, the output has reached close to seventeen million cubic feet.

The Company uses approximately 800 tons of coal daily, but putting this coal through the carbonization process results in the Company doing more with the coal for the benefit of its 123,000 consumers than would result from its use in any other way.

The speaker's own opinion regarding the solution of the fuel problem of the future is in the greater conservation of our fuel resources through the carbonization of the coal, and believes that no coal should be used in its raw state for heating purposes, when there are other sources of fuel supply such as wood fuel on farms, etc., and no coal whatever should be allowed to be shipped to centres where there is an abundant wood supply. Coal brought into the country, or mined in the country, should be turned over to gas manufacturing or coke oven plants where the gas content would be released and sold for such heating purposes as it could efficiently take care of. It would also be distributed in as large an area as possible for domestic, industrial and other heating purposes, at a low price, while the coke residual could be used in the centres not conveniently situated to the coal or wood supply or gas company, and also utilized in metallurgical, foundry and smelter operations, and if necessary, for the generation of steam power.

It may be interesting to this audience to go through a modern gas plant, and in order to make it interesting I have prepared a number of slides which illustrate the process from the earliest times to the present moment, and it will also enable each one of us to see what great strides have taken place in this industry within recent years.

We have here a portrait of Murdock, one of the earliest investigators we know of in the distillation of coal. He was born in Auchinleck, Ayrshire, Scotland, in 1754, and when quite young experimented in the carbonization of coal. Most of us know, or have heard of this clay pipe experiment, and many of the younger generation of the present day, have tried this scheme for producing gas on a small scale. Even in our modern plants, the principles involved in gas production, through means of coal placed in the clay pipe and sealed up, are carried on at the

present time. The bowl represents the retort or receptacle in which the soft coal is hermetically sealed, and after this simple contrivance is placed in a coal fire it will not be long before the gas will begin to rise up the stem of the pipe, which in modern practice would be termed the ascension pipe. I will briefly explain some of the views as we go along.

This view shows Murdoch walking home through the streets of Redruth, Cornwall, carrying a bladder full of gas under his arm. With a burner on the top end he is seen illuminating his way home through the darkness after leaving the works daily.

Here we have the first house to be lighted with coal gas. It is Wm. Murdoch's house at Redruth, which was first lighted in 1792, and which is still in use.

Here we have the portrait of Lebon the Frenchman, who is to be given credit along with Murdoch for his early discoveries in gas making. He did not, however, publically demonstrate his inventions until ten years after Murdoch had lighted his home with coal gas in Redruth.

This is Minckelers—, the Holland Chemist, another eminent man who, report has it, lighted his lecture room with coal gas in 1785.

Coming down a little later, we here see some of the old lamp posts used during the early days of gas-lighting in London, Eng. Gas was then burned in its unpurified state with the results as shown.

Coming to America, we find the first gas light company established at Baltimore in 1816.

An early coal gas plant is shown in the next illustration, and is that as taken from Parke's Chemical Catechism, published in 1810, but with gas, as with most other things, there was no royal road to success. Little was known of its properties and many requirements, as for example, the method of measuring the gas. In the early days the consumers were charged so much an hour, or so much per burner, for the gas they used, but these methods proved unsatisfactory, and it was necessary to have one of the gas company's men go out and tap at the window where the number of hours bargained for had been exceeded, and tap at the window and ask that the light be put out, otherwise the company would send in a larger bill the following month.

A meter, however, was brought out a few years later, by a gentleman named Samuel Clegg, who, like Murdoch, was engaged at the Watt & Soho Works, Birmingham. A picture of Clegg's meter, for it was he who invented the gas meter, is here shown. In the illustration of the early gas works previously shown on the screen we see two essentials in the manufacture of gas as carried on to-day. First, the coal is roasted or distilled in a closed vessel surrounded with heat; second, it is stored over water in the gas holders, but apart from this, how crude was the process.

Beyond the tub, or similar receptacle, to catch the coal, tar and ammonia water, nothing intervened between the retort and the holder.

We may leave off the intervening years with their turmoil and strife and look at the method of manufacture in use at the present time.

One of the first essentials is that the gas works be within reach of a carrying system, as coal is chiefly conveyed by rail, and the works must be constructed at a railway depot or siding. In our works the railway siding runs right into the yards of the gas works, and the coal is stored convenient to the retort or carbonization house. In the average works there must be:—

(*a*) Coal storage facilities.

(*b*) Retorts to distil the coal in.

(*c*) Condenser to cool crude gas.

(*d*) Scrubbers to take out ammonia and some other impurities.

(*e*) Purifiers to take out sulphuretted hydrogen, carbonic acid, carbon bi-sulphide, and other sulphur compounds.

(*e*) Meter to register gas made.

(*g*) Gas holder to store the gas.

Coal is first put into the retort (*b*) and immediately sealed up by placing the lid on the mouthpiece. The joint of the lid with the mouthpiece is made tight by having planed faces which are self-sealing, or by using a lime paste. The retorts are made of silica, fire clay, and usually last about three years. The illustrations are those of what are termed horizontal retorts. These are equipped with openings and doors at either end, thus allowing the coal to be placed in at one end, and when carbonized the residual coke can be pushed clear through from one end to the other.

Here we have the elevation of a retort bench. A bench of retorts contains usually more than one retort. In some works as many as 12 are heated with one furnace. In the illustration there are seven retorts. The heat is caused to circulate evenly round the retorts so as to keep them at a temperature of about 2,000 degrees Fahrenheit, and the products of combustion are carried away through the flue to the chimney. In small gas works the operation is usually carried on by one man, and the illustrations show the man carrying out the three processes of charging, drawing, and clinkering. Here we have him putting coal into the retort; in the second, he is drawing out the coke after all the gas has been taken from the coal. (It usually takes about eight hours to get all the gas required from the coal.) Here he is shown attending to the arduous job of cleaning out the fire which heats

the retorts. If the heats are right nothing will be left in the retort but coke after the eight hour period. Some of this is used for the generator furnace, and the rest is deposited in the yard for sale.

While the coal is being roasted, the gas, together with the tar, and water, in the form of vapor, passes up the ascension pipe, each retort having its own separate pipe. From the ascension pipe it reaches the hydraulic main which is the large pipe placed along the top of all the retort benches. It is partially filled with water, into which the ascension pipe, after passing over the bridge, and turning over in the shape of a "U," dips slightly, and serves the purpose of allowing the gas to pass freely forward, when the retorts are closed, but prevents it from returning when they are open again for the purpose of putting in a sufficient supply of coal. From the hydraulic main the gas passes to the condensors where the gas is cooled sufficient to allow the tarry vapors to change from vapor to liquid, and this tarry matter is collected in wells underneath the condensors. The illustration on the screen gives a very good idea of what these condensors look like.

The next piece of apparatus is known as the exhauster. This machine performs two principal functions. It withdraws the gas from the retorts as quickly as possible, and also overcomes the resistance which the remainder of the gas-making plant offers to the flow of the gas. The speed of the machine is carefully governed. One of the chief impurities in the gas at this stage is ammonia, and special means are used for extracting it.

Ammonia is extremely soluble in water, for the latter will absorb at ordinary temperature over 700 times its own volume of the ammonia gas. When the coal gas leaves the exhauster it is conducted through what we term the scrubber,—in many works this is a cylindrical tower filled with coke or thin boards set on edge in tiers. The coke or boards are kept saturated with water which is pumped or otherwise delivered to the top of the scrubber. The gas enters at the bottom passing upwards and out at the top. The water is distributed by means of liquor turbine, a mechanical means for spreading the water so that trickling down through the coke or boards, it is brought into close contact with the finely divided streams of coal gas going in the opposite direction. The result is that the ammonia leaves the gas and joins the water. The affluent liquid is known as ammoniacal liquor, and valuable by-products are derived from it. Some companies have a different form of scrubber in that the gas is allowed to bubble up through a large body of water, and in this way be cleansed from its ammonia content, and also some of the tarry products. Rotary washer scrubbers are used in many large works for the express purpose of making sure that all traces of ammonia have been extracted from the gas.

When the gas left the retort it contained tar as a vapor,

ammonia as a gas, sulphur in the form of sulphuretted hydrogen, carbon bi-sulphide, and other forms of carbonic acid gas. There are other impurities, but they are of minor importance.

There should now be no tar or ammonia left, but there will be a considerable amount of sulphur in various forms, and carbonic acid. These are removed by a process called purification. The apparatus is illustrated on the screen, and consists of a series of cast-iron boxes. Inside each box are placed layers of bog ore, chemically known as oxide of iron, which takes out the sulphur whilst the gas is passing through it. The gas is now taken to the meter house where the amount manufactured is measured, and from thence to the gas holders, a number of styles of which are shown here.

As the gas enters, the holder rises, except when more gas is being used than is made, when it lowers.

From the gas holder the gas leaves the works to the gas consumers, but before doing so directly, its pressure is gauged by means of a governor which automatically maintains an even pressure on the city mains.

We have now produced through this process, 10 to 12 thousand cubic feet of gas per ton, approximately 60 per cent. of the original weight of the coal, about five pounds of concentrated ammonia, and 10 to 15 gallons of tar, from each ton. These products in themselves when efficiently developed return to a tremendous number of various by-products.

The next few illustrations will show a few well-known products, and the other illustrations that are to follow will give some idea of the great strides made in the gas industry.

There are at the present time over 1,000 uses for gas in the industries of Toronto alone, and the local Company has only touched the fringe of the possible business obtainable from this source. Time does not permit to list these processes, but at another time an opportunity might be presented of showing what is being done in this direction.

FIRE PREVENTION

By W. L. Clairmont, '22.

FROM the beginning of time fire has played a most important role in the world's evolution. It has made and unmade continents, it has been used to generate power, and with it nine-tenths of our food is prepared. Properly controlled, it is our most important ally, but unharnessed and uncontrolled, it can destroy, and has destroyed, in one hour, what nature has taken centuries to create, or what man has spent years in fashioning. How, then, can it be prevented?

Fire prevention is a question that vitally interests every Canadian, man woman or child, and we in Ontario should lead the way, both by word and deed, in furthering it. How many go to bed at night little thinking that the next day will find them mourning some of their loved ones, done to death by the dread fiend, fire? Mr. George F. Lewis, Deputy Fire Marshal of Ontario, states that the estimated death toll on the North American Continent from this cause is 30,000 human beings yearly. Again, how many people are enjoying good, comfortable homes to-night who to-morrow will be homeless? Statistics show that over 6,000 fires occure yearly in the homes of Ontario people, involving in the aggregate a huge financial loss. For the North American Continent, this loss totals up to three hundred and fifty millions of dollars annually.

What Fire Prevention Involves

In fire prevention there is involved everything pertaining to the science of constructing, protecting and occupying buildings so as to minimize the danger of fire. It must not be confused with the narrower definition of fire-protection," applied to the mechanical aids employed to discover, resist and fight fire. For the present purposes we shall consider fire prevention under six heads, (1) in the community as a whole, (2) in the home, (3) in the factory, (4) in the business section of our towns and cities, (5) in the forest, and (6) prevention of fires caused by lightning. Only the most important will be touched upon here.

Educating the Community.

The community has been considered first, rather than the home, since if a fire occurs in a community, not only one's home is in danger, but also those of many other people. What is needed first in the community is an educational campaign, for by means of it there may be brought before the minds of the people the appalling disasters that have occurred, and will recur, if steps are not taken to prevent them. For such work there are many educational facilities at hand, such as the press and public speakers. Continual repetition of cautions will ultimately result in the formation of good habits. In this matter the Ontario Fire Prevention League is doing pioneer work, and their brochure en-

titled "Conservation of Life and Property," if widely distributed and digested, should be the means of saving many lives and thousands of dollars annually. The facts must be made generally known to arouse sufficient interest among its individual citizens to induce them to study the subject, and, as far as possible, to apply the knowledge in their homes. Such information as a list of fires in neighboring towns, records of fire insurance organizations, statistics on the subject by journals continually publishing such facts could all be given a wide distribution by means of circulars. Could not legislation be enacted whereby in the case of fire, if it were found that it had been caused by gross carelessness of the owner, he be made to pay the cost of extinguishing it? He would soon learn to be more careful where he puts his hot ashes, or where he piles his kindling wood at night. In the Napoleonic code—still the fire insurance laws of France—it is provided that an individual must in a measure insure his neighbor as well as himself. This tends to induce more caution, by trying to keep down the fire hazard, and consequently the rates. Many fires are due to the carelessness and selfishness of property owners in our towns and cities, and if public opinion were organized, Legislative Assemblies would not have much trouble in enacting satisfactory laws. Control of Canadian fire waste must come from a careful study of the existing laws in each Province, city and town, followed by the enactment and enforcement of proper legislation to correct bad conditions.

Ontario Fire Losses

Let us compare the per capita fire-loss in Ontario with that in the principal European countries. In Ontario it is $5.00 per annum, while in the principal European countries it is in the neighborhood of 33 cents! What is the cause of this great disparity? The conditions that appear to cause this difference are (1) the larger use of non-combustible materials, due no doubt to the high cost of wood, (2) the stricter observance of better building codes, (3) lower heights and smaller areas employed in city construction, and (4) finally the intangible influence of their older civilization, which makes for greater care in saving and in all their affairs. If a remedy for our great fire-loss lies here, then why not educate ourselves along similar lines?

Fire Prevention in the Home

In the home, cleanliness of the house and surroundings is the most potent factor in preventing fires. The old adage, "An ounce of prevention is worth a pound of cure," applies in this connection as in sickness. Those who have lived in rural Ontario towns remember the spring house-cleanings and yard-cleanings, when the house and yard were gone over thoroughly, and the accumulations of the thousand and one odd things were cleaned out, put in a big pile and burned or else sold to the rag-man.

That was good, but suppose a fire had started before the cleaning-out period. In many cases the useless articles piled away in the cellar or attic would have been the cause of it. It is thus best to keep such articles down to a minimum. Matches should never be put away with the old clothes thus stored.

With regard to matches, the only safe kind to keep around the house are those that ignite only on the prepared surface of the containing box. They should by all means be kept away from small children, rats and mice. It may not be generally known that these latter pests have been suspected of starting a good many fires, as they nibble the ends of the matches to get at the phosphorus contained therein. They have also been known to carry away matches to their nests, which, for the sake of comfort, they build near chimneys or hot-water pipes. The matches become heated on account of their proximity to the chimney, and ignite. The moral is to get rid of rats and mice. Fires often occur, too, from careless smokers throwing away matches without seeing that they are entirely extinct. It is hard to gauge just what damage has been caused by this act, but it should be regarded as a criminal offense.

Other common bad habits that often create fires are, throwing hot ashes into wooden receptacles, using coal oil to start fires, filling oil lamps at night, leaving chimneys and stove-pipes too long without cleaning, and leaving lighted lanterns in dangerous places. Persons indulging in such practices should be forcibly impressed with the fact that they are flirting with fire.

The Factory Hazard

In the factory, too, we must always be on our guard, for if it is burned down, the means of earning a livelihood vanish for a good many people. Very often a fire in a factory affects a whole community, and much hardship and suffering are undergone when men are thus suddenly thrown out of work. Not only that, but the hazard to life is much greater than in a single house, for here are sometimes gathered thousands of people. Here it is that the greatest cleanliness should prevail. Much good would result if employers were to put up signs in their factories, where everybody could see them, to the effect that "Fire in this plant will put every man out of work. Guard the property and save your position." The employees would then be constantly on their guard, having always before them the idea of the dire consequences resulting from a fire. Especially should there be no accumulations of oily waste, for spontaneous combustion from such causes has been frequently known to occur. The greatest care should be taken to get rid of as much dust as possible, more especially in grain elevators and flour mills, for the rapid oxidization of the finely divided suspended matter in these industries has caused fearful explosions under certain conditions, such as a spark from an electric motor or a slipping belt. Once more,

the necessity for cleanliness is strikingly illustrated. Mechanical dust collectors should be provided where processes generate fine dust, as in the manufacture of starch, flour, coal, cork, grain-dust, etc. Chemical works and explosive works should be far removed from a congested area, in order to reduce to a minimum the danger in case a fire takes place. Smoking in factories should be absolutely forbidden. Another danger that lurks in the factory is the careless putting away in closets of tinsmiths' fire-pots, charcoal-furnaces, etc., before cooling.

Working over-hours is also a powerful factor in the destruction of factories, for it produces a sleep indifference on the part of the tired workman. Many fires have been observed by passers-by in buildings where workmen were oblivious to the fact, owing to their tired condition. So it would seem a wise thing, where much extra work was to be done, to put on another shift.

Fire Prevention in the Business District

The business district, being usually the most congested area in any town or city, possesses peculiar hazards. It is possible to walk up any of the business streets of the principal cities and towns of Ontario and see grotesque and irregular roof lines in the different blocks. Such not only cast a reflection on our artistic abilities, but a very great danger in time of fire, being, in many cases, a veritable fire-trap. Drastic changes in our building laws should be resorted to in order to remove this defect. In Paris often one may see block upon block of buildings of an even height, which not only is pleasing to the eye, but is a great help to firemen in fire-fighting operations.

Every building should be fire-proof as far as possible. It is, of course, impossible to make them entirely fire-proof, as witness the results in the great Baltimore and San Francisco fires, where skyscrapers, considered well-nigh fireproof, were gutted. Architects and engineers by specifying the most non-combustible materials for building construction, can greatly aid in reducing our enormous fire-loss.

The carelessness of tradesmen in leaving empty packing boxes, etc., under the grating in sidewalks has been responsible for many fires. The practice is dangerous, for at any instant a careless smoker may drop a cigarette butt or a lighted match through the grating, and a conflagration results. In the storing away of volatile and dangerous compounds, care must be taken not to exceed the lawful amount, for example in the storage of calcium carbide. The sweepings of a floor, following the storing of slaked lime in barrels, and particularly if the floor has been damp, should be carried outside and not put in receptacles inside, for the slaked lime when in contact with water generates an enormous amount of heat. Again, too much care cannot be taken in the storing of oils, bituminous coal, lampblack, charcoal, and even tracing paper. A can or a barrel of oil should never be kept in

the same room with a furnace or stove. As for gasoline, it should be stored in underground iron tanks, away from any building.

Forest Fires

As yet nothing has been said of forest fires. Everyone who has lived in Northern Ontario knows of these dread, almost annual, recurrences, and those who have not have been impressed with their extent by the accounts in newspapers. The problem of conserving our natural resources is receiving much attention of late, and should receive more. Our forests are being depleted at an alarmingly increasing rate with no provision—or practically none—being made for their replacement, and it is incumbent upon us to exercise all the diligence and precaution possible in guarding them from fires. A few years ago locomotives were blamed for setting forests on fire, due to the sparks from the smokestack falling upon the underbrush in the dry summer season. This danger has now been largely removed by the employment of effective spark screens. But why should lumber and pulp companies be allowed to leave a bush in the state of a playground for the wandering spark? Legislation should be enacted to prohibit wanton negligence of this kind.

Settlers also cannot escape responsibility for forest fires, for in clearing up land, they build huge fires, which work their way underground and smoulder for a month or so, and then suddenly burst out in an entirely different locality. Careless campers have also caused huge forest conflagrations by not properly extinguishing their fires or by dropping a lighted match amongst the dry tinder. Before leaving, the camper should see that the fire is absolutely out. Then, too, they should be built in a suitable place, not close to trees or underbrush, and should not be covered with leaves, dry grass or moss.

Lightning Fires

Lightning has caused more fires than one would imagine. For example, in 1919, there were 1,104 lightning fires in all classes of buildings in Ontario, causing a total loss of $506,907. These fires largely occurred on farms and could have been prevented by the efficient installation of lightning rods. It has been demonstrated that where these rods were properly installed, an efficiency of 99 per cent. has been obtained.

We have now seen the numerous ways in which fires can occur and the equally numerous ways in which they can be prevented. The main point to keep in mind is the elimination of ignorance, carelessness and filth by a publicity campaign. Witness the great results obtained in the good roads movement by constantly keeping before the public the need of such highways. Is it too much to hope that the same results could be obtained along the lines of fire prevention by educating the public and forming a strong public opinion in its favor?

University of Toronto Engineering Society

(ESTABLISHED FEBRUARY 6TH, 1885.)

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Secretary..................................T. K. THOMSON
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1913-14—F. C. MECHIN
1914-15—E. D. GRAY
1915-16—C. E. HASTINGS and
W. L. DOBBIN
W. B. HONIWELL
(Acting)
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Professor of Surveying and Geodesy

A. P. COLEMAN, M.A., Ph.D.,
Professor of Geology

Transactions and Year Book

OF

The University of Toronto Engineering Society

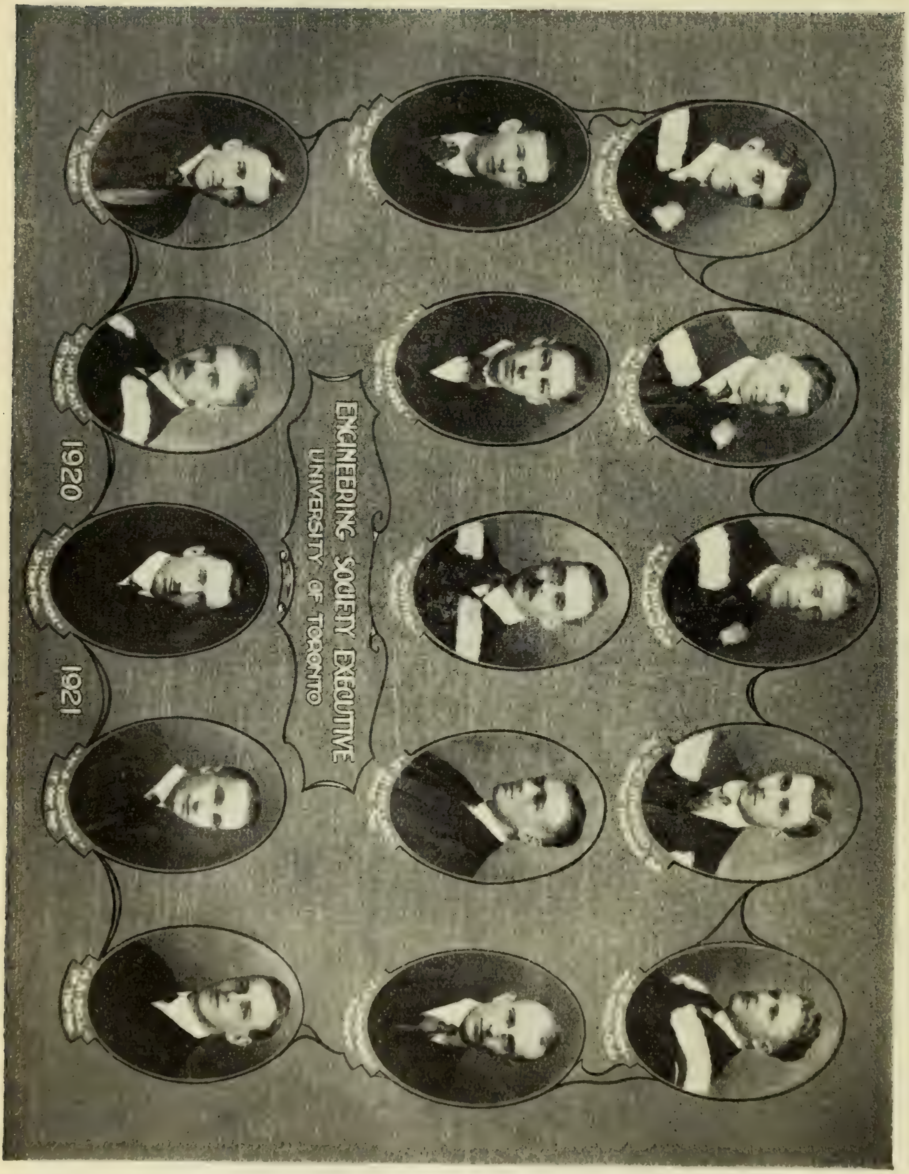
WITH WHICH IS INCORPORATED "APPLIED SCIENCE"

PUBLISHED ANNUALLY BY THE SOCIETY

No. 34 TORONTO, APRIL 15, 1921 1920-21

EDITORIAL

Owing to the fact that this publication goes to press before the books are closed for the year, it has not been possible to publish the Auditors' report. However, the first or Freshman issue of the *Toike Oike* will contain this in full. Mr. Ferguson, who has audited the books of the Society for the past six years, may be numbered as one of the Society's real friends. In the days of our financial difficulties his advice was invaluable, and it is only since the improvement in our finances that he has consented to accept his fee. His comment on the work of the year will be well worth your perusal.


ENGINEERING SOCIETY EXECUTIVE
UNIVERSITY OF TORONTO
1920
1921

A TRIBUTE TO THE LATE DR. WILLIAM HODGSON ELLIS

By James Watson Bain

On August 23, 1920, the University of Toronto suffered a severe loss through the death of its distinguished alumnist, William Hodgson Ellis, LL.D., M.A., M.B., Professor Emeritus of Applied Chemistry and Dean of the Faculty of Applied Science and Engineering from 1914 to 1919.

Dr. Ellis was born in Derbyshire, England, in 1845, and during early boyhood his father emigrated to America and settled in Illinois. To this circumstance, Dr. Ellis owed an experience quite unusual among his Canadian contemporaries, for he could clearly recall listening to one of Abraham Lincoln's campaign speeches, which made a profound impression on his youthful mind. After a few years in the United States, the family moved to Toronto, where Dr. Ellis pursued his studies at the University, graduating first in Arts and then in Medicine.

The Professor of Chemistry in the University at that time was Henry Croft, a man of singularly attractive personality, and an excellent teacher. Largely owing to his enthusiasm, Dr. Ellis became his assistant instead of following the profession of medicine, and after a brief period undertook the additional duty of teaching chemistry in the newly-founded School of Technology, which had been formed to supplement and supersede the older Mechanics' Institute.

When the School of Practical Science was instituted, in 1877, to provide for the training of engineers, Dr. Ellis became the Assistant Professor of Chemistry, and shortly afterwards Professor of Applied Chemistry, a title which he retained to the last. In the medical faculty, Dr. Ellis was for many years Professor of Toxicology and Medical Jurisprudence, in which fields he had a very wide experience. In addition, Dr. Ellis lectured to students in the faculties of Arts and Forestry on Applied Chemistry, with the result that he was well known to many graduates other than those of Applied Science.

In the midst of his university activities, Dr. Ellis found time to act as a Public Analyst for the Inland Revenue Department of the Federal Government, and the exprience thus gained gave to his lectures and laboratory instruction that touch of reality which is so potent an agent in arousing and retaining the interest of students.

During the years of professional activity, he was engaged in practically every criminal case in Ontario where expert testimony in medical jurisprudence was necessary. This brought him into contact with the leaders of the legal profession and widened his already large circle of friends. No other circumstances threw into more prominent relief his outstanding qualities than the investigation of some suspected case of poisoning. No pains were

too great, no precaution was too trivial to be neglected when the laboratory examination was under way, and in the witness box his evidence was so clear, direct and unmistakable that it was never shaken by counsel.

In the course of his long career, Dr. Ellis was called upon to give advice upon a great variety of matters involving considerations of chemistry, and each of these received a careful and thorough study before an opinion was issued. Long after the matter appeared, in the minds of his assistants, to be definitely settled by laboratory evidence, Dr. Ellis pursued every cross trail until he had thoroughly convinced himself that it led nowhere, which illustrates the dislike of hasty judgments, which was one of his well-known characteristics.

In 1914, the first Dean of the Faculty of Applied Science Dr. John Galbraith, died, and at the request of the President, Dr. Ellis became his successor, although he had already made application to be relieved of duty on account of age. The situation was peculiarly difficult. The former Dean had spent time and energy unsparingly in promoting the interests of the "School," added to which his personal qualities had won for him a host of friends; the war had begun to drain the students from the University, which created new and difficult situations; and there was an insistent call for progress and leadership along new lines of work. It was almost too much to expect from a man of 69, but Dr. Ellis shouldered the load cheerfully, maintained the reputation of the Dean for the prompt despatch of business, guided the Faculty in the perplexing questions of student life under war conditions, and initiated among other things the School of Engineering Research, which has abundantly justified his foresight and energy.

Honors, academic and professional, came to him in abundance. He received the honorary degree, LL.D., from both his Alma Mater and McGill; he served as President of the Canadian Institute and as Chairman of the Canadian Section of Chemical Industry. Shortly before he retired, a dinner was given in his honor at the York Club, and a sheaf of congratulatory telegrams from friends and old students from all over North America was the feature of the evening.

Dr. Ellis was passionately fond of outdoor life and had a wide and intimate knowledge of natural history. While at the University, he visited the Muskoka district, at that time an almost virgin forestland, and having once experienced the charm of the North country, every succeeding summer found his canoe in some part of that noble heritage of the Canadian. He was an ardent fisherman, and took the keenest interest in all the intricacies of the art as practised by Isaak Walton and his disciples; indeed, the Compleat Angler was his familiar companion, from which he would quote at will. The scientific bent of his mind was

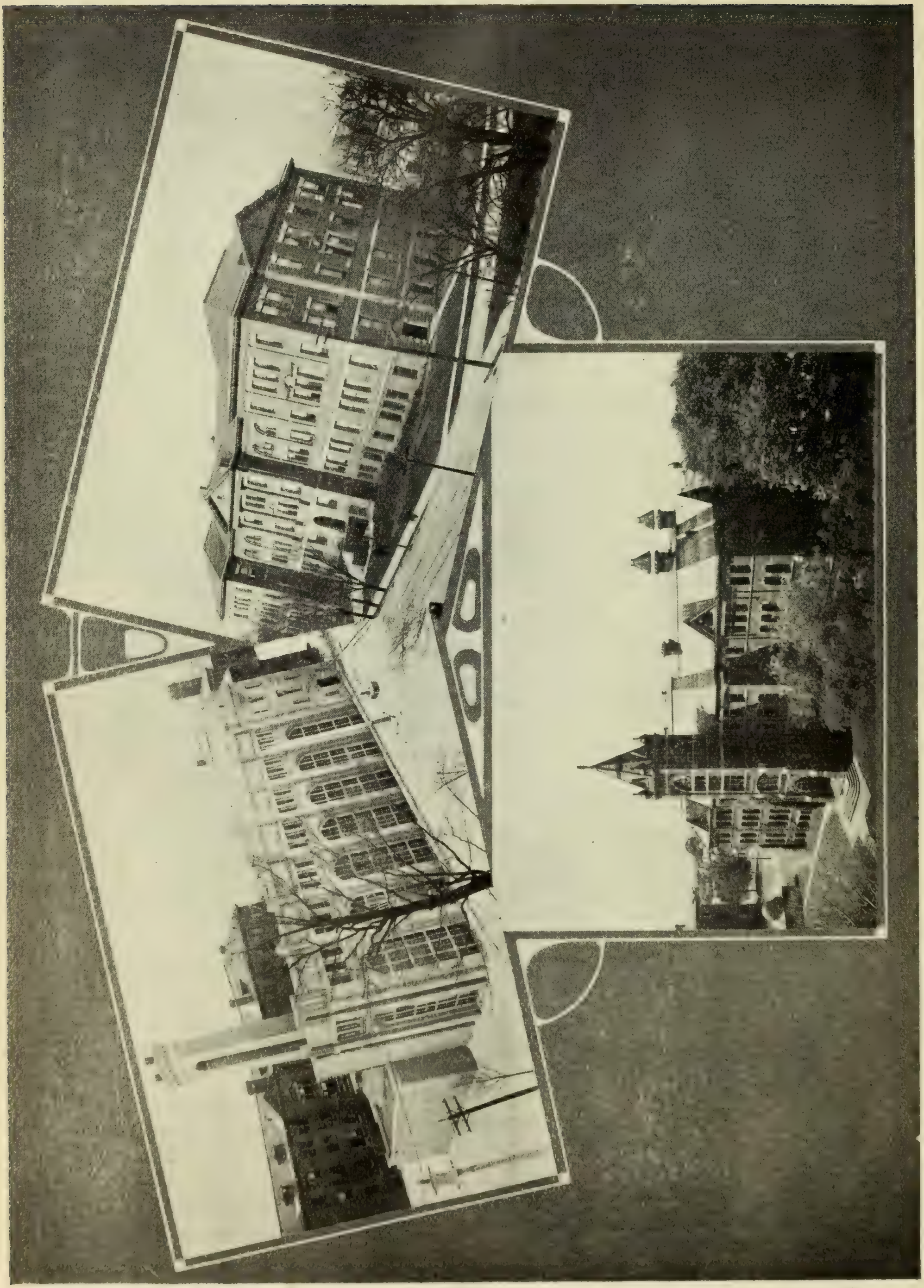
displayed in this connection in the establishment of an empirical rule by which the weight of a black bass could be deduced by its length, a result obtained graphically from specimens which he himself had caught. On May 1st of each year, Dr. Ellis was not to be found by those who sought his professional services, but the initiated were perfectly aware of the fact that he could be discovered in a boat or canoe, trying a new fly on the trout. It was quite natural, therefore, that he visited such famous fishing grounds as the Nipigon River, the north shore of Lake Superior, the Temagami district and many others, long years in advance of the ordinary tourist, and his recollections of these expeditions interested and entertained his friends on many occasions. That the call came to him at last among the woods and waters which he loved so well has appeared to his many friends as particularly appropriate.

Dr. Ellis was very fond of golf and played at the Toronto Golf Club for many years. He further endeared himself to many of his friends by cheerfully enduring their efforts to learn the game or to attain some proficiency in it. One man was heard to remark, after a round, that only a golfer of unlimited forbearance and sympathy, such as Dr. Ellis, could have watched the novice's play without picking up his ball and going home in disgust.

To be a poet, also, was Dr. Ellis' good fortune, and from his pen we have some delightful accounts of incidents usually drawn from outdoor life. Some of his friends collected these poems and published them privately under the title, "Wayside Weeds," a modest book which is carefully treasured by those who loved the author. That Dr. Ellis could sketch excellently and had a talent for extemporizing rapidly with pen or crayon is well known to all the members of the staff of the university, whose annual dinners were enlivened by a series of drawings executed while the artist made a running explanation. These were always novel and invariably humorous; usually some well known topic of the day was treated in inimitable fashion. The flavor of Dr. Ellis' humor may perhaps be best described by drawing a parallel with Lewis Carroll, and had he found time to do so, he might have enriched our literature with a second Alice in Wonderland.

To set down adequately in black and white an account of those traits of character which made Dr. Ellis so much admired and beloved by his friends is quite beyond the power of the present writer, and a few words must suffice. The kindness and sympathy which never failed remain an undying memory to those who knew him, but no mere amiability prevented him from taking a strong stand, cost what it might.

In one of the difficult situations which arose during the war, he alone was serene and undisturbed among the turmoil which threatened to bring about an ugly crisis. To meet Dr. Ellis was



to carry away the impression of a man with whom one could sit on a log, smoking, and discuss almost any subject whatever; and his capacity for companionship without ceremony was an open sesame to the hearts of nearly every one he met.

During the Fenian Raid, Dr. Ellis went to the Niagara frontier as a member of the University Company, and had the misfortune to be taken prisoner. In later years, he frequently referred to his military experiences with an affectionate touch, which justifies us in quoting from "The Happy Warrior" some lines which describe, with all the aptitude possible in language, the character of him who was recognized not only as the head of his profession in Canada, but also as one of its most powerful influences for good:

Who, with a toward or untoward lot,
Prosperous or adverse, to his wish or not,
Plays, in the many games of life, that one
Where what he most doth value must be won:
Whom neither shape of danger can dismay,
Nor thought of tender happiness betray;
Who, not content that former worth stand fast,
Looks forward, persevering to the last,
From well to better, daily self-surpast."

ADDRESS OF RETIRING PRESIDENT

IN a moment of mental aberration I approved of the appointment of the Editor of this volume, and, in a spasm of temporary insanity, I remarked that it was customary for the retiring President to make his farewell bow in the shape of a short article. I make the aforesaid apologies because, had the selection been wisely made, the Editor would have accepted my daily postponements in the light that I intended them and go to press without it, but as it is I am so constantly reminded that I am the last contributor to submit my text, that, fully convinced of his complete lack of discretion and utter unfitness for his position I take this occasion to tell him so, and will proceed to inflict myself upon you for the last time.

What to write about, that is the question. They say the title sells the book. Someone suggests "Professors I Have Known." No, it savors too much of Ernest Thompson Seton—"In Lab. and Lecture." Sir Walter Scott succeeded in describing places he had never seen, but I cannot aim so high. Probably I had better confine myself to something with which I am measurably acquainted, so let it be "The Engineering Society."

As the chief executive of the Society I am occasionally asked "Why is the Engineering Society?" I have been accused of tak-

ing its affairs too seriously. I am informed that when the present generation passes there will come those who know us not and will not miss us. Much more am I told, but all in the same vein.

Now I have never become comfortably acquainted with a slide rule, and, although I have lost my freshman's awe of the higher mathematics, I am afraid that I cannot call them to my aid. Faithful servants of the lamp though they be to my instructors, they know me not. However, perhaps by rule of thumb I may arrive at a result, and, if my logic be not scanned too closely it may convince.

The aims and objects of the Society are all laid down in the Constitution. This would appear to be the conventional thing to do, and framers of such works would seem to become conventional by virtue of their appointment. To me, however, the essence of the matter is that the Society is a self-governing community. A field in which the embryo engineer may learn two lessons: First, the benefit derived by the members of a community working together as an organized body, and second, the lesson of responsibility. With regard to the first, it is one point which the practicing engineer of to-day realizes as his greatest drawback, and one which they are making every effort to correct. As members of any community there are few men as well qualified to enter into the life and activities as the engineer, and yet there is no profession that is more backward in doing so. The community should not be a Haitian Army, but it needs solid, interested, active material in the ranks and that same material is going to be recognized and represented among the leaders. We have here, therefore, a body who are organized to handle their own affairs, to handle public service institutions, and generally be of the most service to their members, an ideal community.

In the case of the second, at first glance it would seem that some score at most will profit by holding positions of responsibility. There were, however, this year over one hundred and fifty members on Committees and Executives connected with the Society. Some of these were probably mere space-fillers, but the large majority of them, given some definite task to accomplish, turned in at the end of their term a work that was a credit to themselves, and to those who had placed them there. The space-fillers will probably be space-fillers to the end of their days. It is said that our character is formed very early in life.

Thus, if it is of benefit that we should learn the value of working shoulder to shoulder for the common good, and, if it is of value that we learn to assume responsibilities, let us take the affairs of our Society with the seriousness that institutions which teach these things deserve.

As to the last charge it would seem scarcely worthy of answer. This is the thirty-fifth year of the Society. Thirty-four executives and thirty-two student Presidents have unselfishly

given their time and energy to further the interests of the Society. Should we then look for more reward than they? Our reward is the knowledge that we have taken over the task from our predecessors, carried it on for the allotted run, and handed it over to those who follow, and our only hope is that those who come after will look back on this year's work and say, "Well done!" We care not that they recall names. If it be said that in the year 1920-21 the affairs of the Society were well run, that is sufficient, or, if some of our actions may reflect to the benefit of years to come, we care not whether they know the origin.

As for the more detailed work of the Society, it has been laid down in the Constitution that the routine work of the Society shall, as much as possible, be carried out by committees appointed from the membership at large. The object of this is twofold. First, it relieves the executive of a great deal of work and gives them more time for general supervision; secondly, it brings more men in the Society's activities, and brings these activities more vividly before the membership at large.

The Constitution of the Society has been printed, and will be distributed next fall to all its members. In ensuing years as each freshman registers, he will be handed a copy in order that he may inform himself of the Society's work.

To too many the objects of the Society are to run a Supply Department, a Dinner and a Dance. These are not the functions of the Society, but merely the most prominent evidences of its one object, viz., to be of service to its members, and it is only by being of service that it can thrive and maintain its place in the "School" life that it has always held.

The Supply Department must not be looked upon as a profit-making institution, but rather as a self-supporting department of the Society's activities, which by virtue of the slight percentage of profit it makes, shall have sufficient funds on hand to offer service that no competitor can. Its aim should be service. At the same time, it must be run on a thoroughly business-like basis, and a sufficient reserve should be built up and maintained to provide for depreciation and losses in stock.

The Annual Dinner should be one of two get-together nights. The other, being election night, is rather too lively to replace it. This should be borne in mind by the committee, and the price and programme should be arranged accordingly. Facing a certain deficit in the dinner expenditure is merely another service that the Society can offer.

The Dance, although a later development in the activities of the Society, has assumed its place in University life. However, as its appeal is limited somewhat, the financial stand of the Society should be rather that of a guarantor, and the effort of the committee should be to put on the best function possible at cost.

I feel that these, as well as the other activities of the So-

CIVIL ENGINEERS' CLUB EXECUTIVE—1920-21.

Back Row—T. S. Glover, Varsity Representative; T. R. Emerson, 1st Year Representative; C. B. MacQueen, Secretary-Treasurer; W. J. Foley, 3rd Year Representative; M. C. Kelly, 2nd Year Representative, H. J. Elliott, 4th Year Representative.

Front Row:—Prof. C. R. Young, Hon. President; P. J. Culliton, President; E. W. Cockerline, Vice-President.

ciety, have been covered by those most intimately concerned, so lest I weary you by repetition, I will say no more.

The King is dead. Long live the King. The thirty-fifth executive of the Society has handed over the keys of office to their successors, and wishing them every success, congratulate you on your choice.

Personally, I thank the members of the executive who have worked so loyally this year, the Faculty Committee who have at all times been so willing to help us, and the members at large, for their continual support.

RALPH WALDO DOWNIE, President.

ADDRESS OF RETIRING CHAIRMAN OF THE CIVIL CLUB

HAVING been asked to contribute something to the "Proceedings" as retiring Chairman of the Civil Club, it is not entirely to Civil Club matters that I will confine myself, but to some matters which should be of interest to all members of the Engineering Society.

With the readjustment of the affairs of the Society under the very able leadership of Mr. R. W. Downie, Committee Chairmen were struck, and it fell to me to conduct the annual dance and dinner for the Society. With regards to the dance, I have nothing to say beyond that it was a success, far surpassing my expectations. With the dinner—a different story is to be told. The dinner was not the success that I had hoped or anticipated. Less than 300 tickets were sold to under-graduate members of the Society. With an attendance of over 800 this is a very low percentage. What is the trouble? Where does the difficulty lie? In so far as I can see, the failure lies with the absence of sufficient school spirit, so manifest in years gone by. It was my privilege to represent the Society at the annual dinner of the Engineering Society of Queen's University this year, and among the things that impressed me was the fact that of a membership approximating 400 there were 300 of those members present for the dinner. Wherein then lies the difference? Are our numbers too unwieldy? I don't think so. Are we too much segregated so that all will not be reached alike? I don't think so. Is individual interest waning? I don't think so. Each one of us wishes to see the Science Faculty at the upper rung of the University ladder, and each one of us secretly hopes that it will stay there. Are there too many outside influences? No—not for the ordinary "School" man. By outside influences I mean those influences entirely separate from University affairs.

The social whirl within the University is too strenuous. In two ways is this so, one of which is the apparent fact that the pocketbook will not stand the strain, and ultimately collapses.

Could we not, within the School, reduce our socialities? Even this year we had quite a number of dances—I believe eight in number. Besides this, there was the dinner and Spasms. Is this too many? Some may not think so. This means an outlay of at last $60. The result of this is that something must be passed up. Dances do not create the same good feeling and fellowship so much desired among School men as the dinner does. If I might be permitted to make a suggestion, I would advance the idea of having four dances during the year. The School dance, the graduating dance, a Junior School dance put on by the first and second years and a Senior School dance put on by the third and fourth years. These, together with the dinner and Spasms, would be six functions in all. If this were followed out, I think that none would be failures. If this is not enough, let the School man attend some of the other Faculty functions. Besides this, there are the games, which calls forth derision if not well attended.

With all this we must not lose sight of the primary object of our presence at School—that of garnering sufficient technical knowledge, so that we might, upon graduation, be efficient engineers. In no Faculty in the University is the course more strenuous than Engineering. It demands the utmost ability of all of us, and if we do not devote a certain amount of time to this, we are losing part of what we come to School for.

In reviewing the activities of the Civil Club during the year, I feel that I did not devote the time that I should have to the matters directly concerning the Club. I had hoped to enlarge upon the activities so well started by Mr. E. C. Cowan two years ago and admirably continued by Mr. R. Harrison last year, but pressure of other School proceedings prevented this, and the work of the Club was left largely in other hands. In this connection my sincere thanks are extended to Professor C. R. Young, the Honorary Chairman of the Club, and to Mr. E. W. Cockerline, the Vice-Chairman, both of whom worked with undying enthusiasm to make the activities of the Club top-notchers.

In the early part of the year a smoker was held and voted a success. Mr. R. O. Wynne-Roberts, Chairman of the Toronto Branch of the E. I. C., and Professor C. R. Young both spoke briefly at this. Then meetings of the Club were arranged during the year, and some very prominent men in the Engineering profession addressed us. At our first meeting Dr. T. Kennard Thomson, one of the earlier graduates of the School, the founder of the Engineering Society, and the only man upon whom the University of Toronto has conferred the honorary degree of D.Sc., presented a paper on the Greater Niagara Development. Two subsequent meetings were held, addressed by Mr. W. P. Murray and Mr. Jas. Robertson, both engineers of prominence, connected with the Dominion Bridge Company. Another address

was given by Col. H. C. Boyden, of the Portland Cement Association, on "Recent Developments in Concrete." At our last meeting a paper was presented by Mr. Wm. Gore, M.E.I.C., on "Reservoirs." These meetings, although tolerably well attended, did not draw sufficient numbers to warrant such work being expended in arranging them, and the last meeting was almost a disgrace. The average student does not place sufficient importance upon the experience of practicing engineers.

Trips were conducted to different places of interest in Toronto, and were well patronized.

A pre-war condition was re-instituted in the formation of the new Structural Club which commands particular commendation. Mr. G. D. Maxwell was elected Chairman of this Club, and the affairs of it were well conducted.

Part of the fees collected was for the purpose of conducting an employment bureau which was started by Mr. Cowan, but confliction arose between the Club and the Faculty, so that I had a motion put through, whereby the Engineering Society did this centrally, thus allowing a greater portion of time to be spent in arranging meetings, etc.

It is with considerable pleasure that I now introduce my successor, Mr. G. A. McClintock, to you.

P. J. CULLITON.

THE MECHANICAL AND ELECTRICAL CLUB

THE request has been made that the writer, as Chairman of the "Mechanical and Electrical Club of the Engineering Society," review the activities of that organization during the year just drawing to a close. In complying with such a request it is the intention to offer such constructive criticism as will be of value to his successor in office.

During the past year six meetings of the Club have been held, including a smoker in Hart House, being an average of one per month, which is all that provision has been made for with respect to general meetings. All meetings, with one exception, were well attended, and all the addresses proved entertaining and instructive. The value of advertising such meetings as may be held cannot be stressed too greatly. The writer would advise inserting notices in the *Varsity* for at least three issues before the date of any meeting, and the conspicuous posting of large placards at least one week before the meeting. This done, one may rest assured that the audience will satisfy all expectations in point of numbers.

As to speakers for such meetings, it would seem advisable

MECHANICAL AND ELECTRICAL CLUB EXECUTIVE, 1920-21.

Top Row:—G. W. Smart, Curator; Prof. R. W. Angus, Prof. H. W. Price, Honorary Chairmen; A. W. F. McQueen, Treasurer.
Seated:—M. C. Stafford, Chairman; B. H. Johnston, Secretary.
Inset:—G. A. Brace, Vice-Chairman.

to consult members of the faculty in the matter. They are only too willing to offer excellent advice upon the choice of such men as they know. Care should be exercised to obtain gentlemen who are fluent in their speech and at the same time are able representatives of the particular branch of Mechanical or Electrical Engineering in which they may be engaged. It might also be here pointed out that too much technical harangue detracts a great deal from the value of an address, in the eyes of the average under-graduate, especially in the lower years.

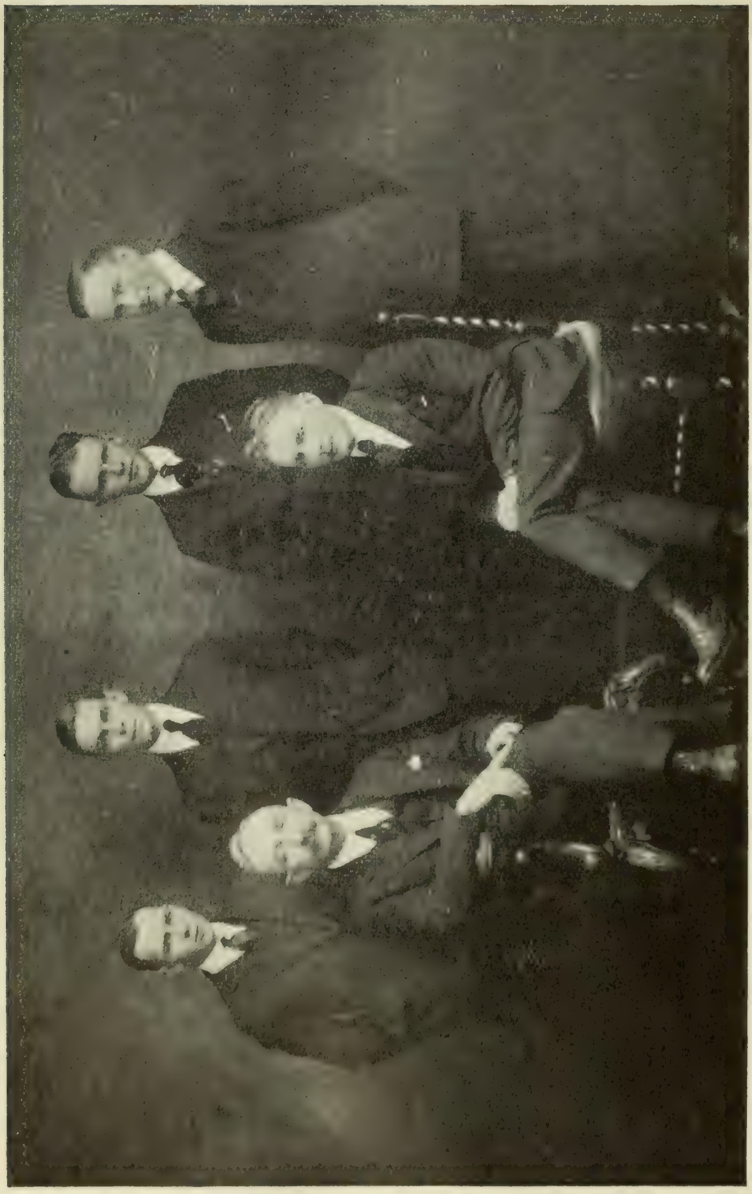
The "annual dinner" for the past two years has been sidetracked, but this last year there was substituted a "smoker." To the writer's mind it appears that a "smoker" held once a year, or even twice during the year, is far more suitable than a "dinner." At the former everything is strictly informal, those present get a chance to mix together and become better acquainted, and, taken on the whole, such a function is more conducive to social intercourse. The "smoker," being by far the cheaper affair, attracts a great many more eager participants than would be so in the case of the more costly "dinner."

The Chairman of the Club will find, upon his succession to office, that as a member of the central executive of the Engineering Society, there devolve upon him many duties which he did not before realize would fall to his lot. It behooves him then to do his utmost to bring about the election of a strong Club executive, an executive upon which he will have the confidence to shift a great many duties, knowing that such duties will be faithfully looked after. In closing I wish to congratulate Mr. Duncan upon his election and to wish him the greatest possible success in his administration of the affairs of the Club.

M. C. STAFFORD.

THE MINING AND METALLURGICAL CLUB

THE year 1920-21 has been a very successful one for "The Mining and Metallurgical Club." The primary object of this Club has been to enable the students to keep in close contact with the "Field," even though they may be pursuing their studies in a place hundreds of miles away from the mining camps. One way of doing this is by having prominent teachers in the mining and metallurgical world come and address the students at informal "smokers" and meetings. The Club was remarkably fortunate this year in being able to secure as speakers, men very high up in their various professions. Another good point concerning these meetings was that a very inspiring feeling of good fellowship was created among the members as they met on a common ground, and had a hearty, jolly time together. The popularity of these was further shown by the incredibly large attendances at all of them.



MINING AND METALLURGICAL CLUB EXECUTIVE, 1920-21.

Top Row:—C. M. Beck, Vice-President; R. J. Henry, Secretary; F. J. Lyle, 2nd Year Representative; J. Beattie, 1st Year Representative.

Bottom Row:—Prof. G. A. Guess, Hon. President; A. E. O'Brien, President.

The first "smoker" was held at Hart House in November with a record turnouut. "Coal" was the subject of the evening, and Mr. James McEvoy, a very prominent Mining Engineer and Geologist, gave a splendid address on "The Utilization of Western Coals in Ontario." Mr. McEvoy is a well-known authority on this subject, and his lecture was most instructive and interesting.

In December another "Coal" evening was held, at which a large number of the wholesale and retail men were present. Though the courtesy of the Sullivan Machinery Company, a three-reel moving-picture on "The Story of Coal" was shown. Before the picture was given, Professor Alexander Maclean, of the Geology Department, who has done a great deal of work in the Western coal fields, gave a very enlightening and interesting lecture on "The Origin of Coal." The moving-picture then took the audience to Pennsylvania, deep down in a coal mine and through every operation from the mining to the shipping. Finally, Mr. H. A. Harrington, Fuel Controller of Ontario, closed the evening with a very witty and timely talk on the troubles encountered by a Fuel Controller in the distribution of coal.

In January, a very successful "smoker" was held, and Mr. George Allan, Advertising Manager and Educational Director of the Consumers' Gas Company, delivered a wonderful illustrated lecture on 'Gas." This is published in another part of this book, and so needs no further mention except that Mr. Allan cast a great light on this most obscure subject.

The activities of the Club were brought to a close by an open meeting, on March 2nd, at which the whole "School" was present. Colonel Arthur L. Dwight, of New York, President of the Dwight-Lloyd Metallurgical Company, and one of the most famous metallurgists on the continent, gave an address on "Ore Roasting and Sintering." Col. Dwight is the inventor of the Dwight-Lloyd Sintering Machine, and so dealt with his subject as no other man could. This address is also published in this book.

ADRIAN E. O'BRIEN.

THE ARCHITECTURAL CLUB

THE ARCHITECTURAL CLUB of the Faculty of Applied Science and Engineering, although not known to many members of School, is a most active organization, and a most successful year has been brought to a close under the able leadership of the Executive, of which the members are: Hon. President, Mr. H. A. Moore, President Ontario Association of Architects; President, T. J. Young '21; Vice-President, E. W. Haldenby '21; Treasurer, M. A. Norcross '22; Secretary, A. S. Crawford '23; Councillors, J. B. Helme '22, J. G. Magee '23, A. R. Smythe '24,

The opening meeting of the Club was held at the Mulberry

INDUSTRIAL CHEMICAL CLUB EXECUTIVE, 1920-21.

Standing:—H. B. Meyer, 3rd Year Rep.; H. N. Baker, 1st Year Rep.; E. M. Begg, 2nd Year Rep.; C. P. Lailey, 4th Year Rep.

Sitting:—H. Kesteven-Balshaw, Sec.-Treasurer; Prof. J. W. Bain, Hon. President; A. D. R. Fraser, President; Prof. E. G. R. Ardagh, Hon. Vice-President; C. J. W. McKeown, Vice-President.

Tea Rooms, on which occasion Dean Mitchell introduced to the Club the new Professor in Design, Mr. Adrian Berrington, late of the University of Liverpool. Prof. Berrington gave a very interesting talk on "The Classic Style of Architecture."

Later in the season Mr. H. A. Moore, the Honorary President, gave a very interesting address on "The Modern Methods of Architecture," in which he dealt principally on the difficulties encountered by students after graduation.

The senior members of the Club also enjoyed several tours of inspection, among which were, the inspection of "Pantage's," through the courtesy of Mr. Baldwin, of the Department of Architecture; the visit to the plant of the Standard Sanitary Co., Limited, under the leadership of Mr. H. H. Madill; and the trip to the factory of the Dunham Co., Limited, which was arranged by Professor C. H. C. Wright.

The entire Club, however, had the pleasure of inspecting the King Edward Hotel extension, and nearly all have selected their rooms for future occupation.

The grand finale, however, occurred on March 11th, when the annual elections were held, and the following officers elected: President, J. B. Helme '22; Vice-President, M. A. Norcross '22; Treasurer, J. G. Magee '23; Secretary, P. A. Deacon '24; Councillors, F. B. Brown '23, E. M. Coleman '24.

The election of an Honorary President and Freshmen's representative were left over till next fall.

THE INDUSTRIAL CHEMICAL CLUB

THE INDUSTRIAL CHEMICAL CLUB was founded in the session of 1908-1909 as an independent Club to further the professional and social interests of the men in the Chemical Department. Prominent among those who fathered it were Mr. MacKenzie Williams '09, of the the financial firm of A. E. Ames & Company; W. H. Thom '10, of Lyman Bros.; A. R. Duff '09; A. E. Gooderham '09; A. V. DeLaporte '10, Chemist in charge of the Experimental Plant of the Provincial Board of Health; E. R. Williams '11, and Mr. A. R. Bonham '14, Chemist of the Province of Ontario.

Through the ensuing years the Club was firmly established by the earnest work of its successive Executive Committees, providing a means of developing public speaking among its members, and organizing the Chemical students into a definite body.

In 1914 the Club was incorporated with the Engineering Society, as one of its sections. By a recent revision of the Society's constitution, the Club, in common with the other sections of the Society, was drawn closer to the central organization. This revision of the constitution provides for financial grants be-

ing voted to the sections in case of necessity; and for safe-keeping of their books, properties, etc., by the Curator of the Society during the Summer Vacation.

During the past Session, 1920-21, the Club abandoned its monthly dinners of former years, and substituted for them monthly smokers in Hart House, held more or less regularly. It was felt that a substantial attendance could not be expected at dinners, considering all circumstances. It is to be hoped that conditions in the future will permit of a return to the old order, for unquestionably a dinner is more pleasant than a smoker. Indeed, it is expected that the Executive of 1921-22 will restore "the ample board."

The session of 1920-21 commenced with the following Executive in office: Honorary President, Professor J. W. Bain; Honorary Vice-President, Professor E. G. R. Ardagh; Chairman, A. D. R. Fraser '21; Vice-Chairman, C. E. J. McKeown '22; Sec.-Treas., H. Kesteven-Balshaw '23; Curator, R. A. Gordon '24; Year Representatives, C. P. Lailey '21, H. B. Meyer '22, E. M. Begg '23, H. N. Baker '24.

During the year a number of very interesting addresses were presented to the Club.

Mr. W. H. Thom '10 delivered a paper on the "Treatment of Raw Drugs." Mr. Thom described the various drugs of vegetable origin which are commonly used in pharmacy, naming their sources and the processes to which they are subjected in refining. A practical demonstration of the general method of extraction added a pleasing feature to the address.

Mr. G. Norwood Comley, Manager of the Canadian Brunner Mond Co., of Amherstburg, Ontario, spoke on the "Soda Industry," paying particular attention to the plant operation of the Solvay Process. Present on the cccasion was Sir Edmund Walker, President of the Brunner Mond Co. Sir Edmund, in a short address, recalled the early days of the Western Peninsula of Ontario, and showed how its promise had been fulfilled by the establishment of the soda industry in the centre of the salt district.

Mr. C. Price Green, Commissioner of Resources of the Canadian National Railways, addressed the Club on "The Natural Resources of Canada." Slides were shown of centres and individual mills from the Atlantic to the Pacific. Mr. Price Green dwelt at length on the pulpwood resources of the Dominion.

Harold J. Roast, of Montreal, Secretary of the Canadian Institute of Chemistry, presented a very valuable paper full of sound advice to the young Engineers. It is reproduced at length in the "Transactions of the Engineering Society."

Mr. Sowers, of Buffalo, New York, exhibited a collection of slides of the famous "Dopp" Jacketed Kettle. Pictures were shown of apparatus made specially to order for certain firms, de-

signed to overcome the difficulties in the process of manufacture. Many ingenious devices were described. Mr. Sowers, on leaving the City of Buffalo, presented two laboratory-size jacketed kettles to the Department of Chemistry.

The Club undertook a personal canvass of the chemical industries in the Western and Central parts of the Province during the Christmas vacation, in an effort to secure summer employment for its members. No immediate success was attained, nor has subsequent correspondence resulted in the placing of any men. In the words of most of the replies to our letters, "we regret that the unsettled state of the industrial field makes it impossible for us to offer you any openings." The campaign, however, regarded as missionary work, was very promising.

The Club's year closed with the final meeting, in the form of a dinner, in Hart House on Wednesday, March 16th. Professor J. W. Bain, Dr. M. C. Boswell, Professor E. G. R. Ardagh, and Professor Adams represented the Staff. Mr. L. E. Westman, Managing Editor of *Canadian Chemistry and Metallurgy*, was also present. After brief speeches from the Staff and from Mr. Westman, the newly-elected Chairman for the coming year, A. E. H. Fair '22, took charge of and adjourned the meeting.

The Executive, on behalf of the Club as a whole, wish to thank the speakers who contributed so largely to the year's success. Their thanks are also due the Staff for the interest which they took in the Club's plans.

SCHOOL HISTORY

The School has a history, not the kind that appears in the calendar, or that which used to be popular with textbook writers (never with pupils), but a real history, a story of people and the events that went to fill up the year and build a tradition around the "Old Red School." If you doubt it spend a few hours with some old grads, and you will cease to wonder at the large gatherings at the Alumni reunions.

Should not some effort be made to collect and publish either in these pages or separately, the story of the Old School? The Executive this year hoped to do something, but were unable to find time. Let us hope that there will be sufficient interest shown to bring this matter before their successors.

THE DEPUTY FIRE MARSHAL'S PRIZE ESSAYS ON FIRE PREVENTION

To bring the work of the Ontario Fire Prevention League more closely before the Engineering Students, and to promote

FACULTY OF APPLIED SCIENCE AND ENGINEERING, FOURTH YEAR EXECUTIVE.

Top Row:—H. J. Elliott, Civil Rep.; C. C. Wimperley, Varsity Rep.; G. Dean Maxwell, Secretary-Treasurer; inset, C. P. Lailey, Chemical Rep.; T. J. Young, Architect. Rep.; G. A. Brace, Elec. and Mech. Rep.; A. E. O'Brien, Mining Rep.

Bottom Row:—J. Roy McLean, President; T. R. Loudon, B.A.Sc., Honorary President; J. Roy Gilley, Vice-President.

an active interest therein, Mr. Lewis, the Deputy Fire Marshal of Ontario, has donated a group of prizes for essays on the subject of "Fire Prevention." The contestants were divided in four groups, as follows: Group I., Civils and Architects; Group II., Miners; Group III., Electricals and Mechanicals; Group IV., Chemists. The prize for each group is textbooks to the value of $15, of the student's own choosing. Owing to the fact that it was not until late in the year that news of this offer was received, the response was not as great as it should have been. Essays were received from Groups I. and II. only, and the essays of the winners, W. L. Clairmont, 2T2, Civils, and A. L. Irwin, 2T1, Metallurgists, are published herein. It is to be hoped that Mr. Lewis may see fit to continue this competition next year, and that its announcement in the fall term will meet with a hearty response.

2T1

PERHAPS the present graduating year is more unique than any that has ever gone out of the "School" heretofore. So far as the different entrance years are concerned, we are without a doubt the most cosmopolitan crowd ever graduating. We have men with us from almost every year since 1T3. However, on the whole, the members of this diversified year have supported admirably well, everything undertaken.

Concerning the activities, very little need be added to that which the majority of us already know. Early in the fall a very enjoyable smoker was held and voted a decided success, in that the boys were all glad to be back renewing old acquaintances and forming new ones.

Later in the term an informal dance was held at the Metropolitan Assembly Rooms, where the members were again given the opportunity of enjoying themselves as only "School" men can.

During the term the "Structural Club" was again brought back to life after a dormant period of several years. Mr. G. D. Maxwell was elected Chairman of this organization and deserves credit for the work carried on. Among other places visited by this club was the new King Edward extension, where Mr. Hagarty, a "School" grad, and the Structural Engineer in charge, kindly explained things of interest. Professor C. R. Young, the Honorary Chairman, accompanied the club on this trip, and also directed the attention of the members to interesting and modern Structural Engineering.

During the first term a trip was also taken to Niagara Falls, Ont., when a tour was taken over the construction of the Hydro

Chippawa Power Development. Our thanks are tendered to Professor Angus, who was in charge of the tour, and also to the Engineering Staff of the Hydro Construction, who did everything possible to make our visit to the work an enjoyable one.

The crowning event of the year, however, took place on January 11th, when the Graduating Dance was held in Jenkins' Art Galleries. The following kindly consented to act as patronesses, Mrs. C. H. Mitchell, Mrs. C. H. C. Wright, Mrs. H. E. T. Haultain, and Mrs. T. R. Loudon. A novelty dance was conducted during the evening, and the prize was tendered to the winner by Brig.-General C. H. Mitchell, our Dean.

My sincere thanks are extended to Mr. J. R. Gilley, Vice-President, and Mr. G. D. Maxwell, Sec.-Treasurer, of the year, for their co-operation and hard work in order that the activities of the year might not lag.

J. R. McLEAN, President.

2T2

THE past year for the class of 2T2, has been a most successful one. Quality, rather than quantity, has been their motto with regard to class functions. In fact, this was almost a necessity, in view of the many affairs, social and otherwise, which have found a place in our University life.

Two smokers were held, one during the Fall term, and one during the Spring term. The first was most successful, from the point of view of attendance, while both were successful, from the point of view of those who attended. Cards, smokes, eats, and an excellent programme by three or four of the year's distinguished musicians, comprised the evening's entertainment, in each case.

Another most important event of a similar nature must not be forgotten here, namely, the Gull Lake smoker. The first part of the evening was taken up by a very exciting game of indoor baseball between those deadly rivals, the Civils, and the Miners. This was followed by a very generous feed, and short speeches by two or three members of the Staff.

The Year dance, which was held at the Metropolitan Assembly Rooms, was one to be remembered. While, of course, not to be compared with the "School" dance, it was, nevertheless, one of the finest class dances at Varsity this year. If you don't believe it, ask anyone who was there.

The only official trip taken by the year was that to Buffalo, to inspect the Lackawanna Steel plant. Unfortunately, it came at a time when the finances of most were at low ebb. However, the thirty or forty, who were able to go, derived considerable benefit therefrom, in addition to the fun of the trip. The arrange-

ments were made by Professor Loudon, and much thanks is due him for his work and interest in the whole thing.

This review would not be complete without some mention of our individual successes in various activities. To begin with, the two best skits in "Spasms" were put on by men of 2T2, one by the Chemicals, and the other by the year as a whole. Then in athletics, and other activities we have had several shining lights. Beattie Ramsay, the Captain of the Hockey Team, and of whom we are all justly proud, is a member of 2T2, as is likewise "Spike" Carruthers, the Captain of the Track Team, and one of the best athletes in Canada. Besides these two, many others have brought glory to themselves, and to "School," in all the various branches of athletics. And this article would still be incomplete, without some mention of the Editor of *Varsity*, "Fat" Gardner; the Leader of the Toike Oikestra, "Scottie" Hamilton, and the Billiard Champion of the University, "Happy" Philp.

"2T2" may therefore be justly proud of its activities during the past year. Not only have the class festivities been all that could be desired by the most exacting person, but, in the broader lines of University activities, 2T2 has come well to the front. It has demonstrated what a solid, united class spirit among all the members of the year will do towards the success of any undertaking.

H. G. THOMPSON.

2T3

ELECTION time is the only occasion outsiders compliment our class. At that time we learn from some of the candidates in a very profuse mixture of sophistry and blarney just how great and fine a crowd we are. Confidently, dear reader, they say we are a powerful body in the Faculty of Applied Science. But election day is past, and some of us who were so sophisticated as to believe the candidates are forced now to tell the plain truth about ourselves. You know what H. H. Lawson said about that. In October, 1920, we started out 402 strong—over fifty per cent. returned men—, but through the untiring work of "Tony" Reid and his executive, within six months this mob was transformed into a harmoniously working body who had accomplished big things. The old soldiers' "Prep Class" was the backbone of the organization. Then our first misfortune befell us. The events which were carried out in the early part of April were the cause of a considerable number of our pals being taken from us, many of whom were the bright men of the year, but whose patriotism and interest in class activities cost them dearly. Even if not in engineering achievements, many of these men will be famous in other lines.

However, those who are simply taking their course in five years instead of four are and always will be 2T3.

In October, 1921, 320 of us started out on the second lap, no sadder, but a wiser lot. There is no need here to deliberate on the depths into which we have been led, and which we explored—more or less—because these are known to all School men except the Frosh, and here we say, "Poor Frosh." In the labs and draughting room Sherman is often quoted, with the local work substituted for war, but we wish to quote the gentleman who wrote "Ignorance is bliss." In this regard we would refer again to the wisdom acquired last year. Last year, at frequent intervals, a large contingent of 2T3 would give the Profs a holiday and help Mr. Solman's Building Fund by attending one of his sessions. He didn't seem to appreciate it as much, though, as do the Arts girls when you assist the W.B.F. by renting a portion of J. and J. J. Allen's moviedrome for an evening, and ofttimes, it seems, from reports of the faculty office, our presence caused him uneasiness. This year, however, our excursions led us not to King or to Richmond St., but to Baldwin's Steel Plant, the Consumers' Gas Co., and the Hydro Laboratories.

In social functions we had a good year. Our big night was when we introduced the Frosh to School customs. It was a ripsnorter. The Dean said it was a great initiation, but, thanks to the wily custodian of the Goat, he didn't see all. The Frosh returned the treat by a fine theatre party down town. Some of the boys remember it; some don't.

We had two good dances which were well patronized and enjoyed and were a credit to the Dance Committee.

The year is well represented in all the Faculty, University and Hart House organizations. There are a great many who attend the E. I. C. meetings and are student members. The E.I.C. Convention meeting and smoker found many 2T3 men present.

Much credit of the success of SPaSms is due to C. T. Carson, stage director; D. MacBeth, stage manager, and O. D. Johnston, business manager.

All executive positions were keenly fought for in the elections, and good men were elected, Bert Morris and Jack Coulter both being raised from the year Executive to the Society Executive. "Spud" Murphy will fight our battles in the Council.

In athletics we certainly contribute our share to the University and Faculty teams. A brief survey of the University teams shows one or more representatives on each one. First Rugby Team—Duncan, Earle, Rolph, Carew and Sullivan (1st year, but still 2T3). Hockey—First team, Sullivan; second, McCullough and Thomson; 3rd, Greey. Basketball—Duffill. Boxing—Relyea, Seaborne and Goldie. Track—Meredith. Swimming—Wells, Lindsay, Harston, Fitzgerald. Water Polo—The

four swimmers, Schinbein and Bell. Tennis—Williams. Rowing—Bell and Smith. Soccer—Evans and Johnston.

This makes a dozen "T"holders and a great many "S"holders. Next year Senior School wants the Mulock, Sifton and Jennings Cups.

Pat Lyle surely started something when he instigated inter-group competition. Here are some results: Chemicals beat the Miners by 38-8 in a close game of basketball—that is the men were close to each other. However, the Miners came back at the Chemicals by 2-1 in a game of hockey, but the Civils worked off a few pounds when they led the Miners home in a 15-man relay race. The water polo game didn't come off.

Of course, there is no use trying to get into School a week early next fall, but in conclusion there is 90 "bucks" in the treasury, and John Farley is our new President.

A. A. BELL.

2T4

AT the beginning of each academic year, just when the leaves are beginning to put on their autumn colors, a new class is formed; new acquaintances are made, new friends meet, and new experiences are felt. This has been true of 2T4; and as each member of the new year found his way to the "little old Red Schoolhouse" new and individual sentiments made themselves known, for was not this the beginning of life's work—but enough of sentiment!

After days of seeming whirl and confusion, the routine was discovered—quite accidentally by some. All had learned to think of themselves as "University" men. The all-important elections were held, and fortunately, or through excellent judgment, a splendid executive was chosen. This meant a good beginning for a good year, as late events have shown.

But this was not all in those "early days." The Dean took advantage of the first opportunity to address and welcome this class of 2T4. His remarks were full of anxious warning against too much frivolous social activity, and to the younger he pointed to the fact that they were to a greater extent their own masters now, and should live accordingly. It is quite certain that this timely warning was not without its good results.

Here, now, cometh a very much remembered event, warmly so, indeed. That event was the initiation. For some weeks many were the hazarded guesses and many were the suspicions concerning this woe of the Freshmen. At last the evening came, and, in clothes suggestive of the ash-cans and garbage heaps, the Frosh lined up in "alphabetically order," and, one by one, went through those awful degrees at a spanking good pace to a final

demonstration of the mysteries of "School," on the top floor. The clause of secrecy does not permit a full description; so let us pass on to the next event of the year, which was the "smoker," and of particular interest, because the terrible offenders who had deserted their comrades in the face of the initiation, were to be justly punished. After a close investigation and trial the offenders were found guilty and sentenced to the same treatment as had been meted out to their fellows. In the presence of all and sundry the sentence was duly executed. Again secrecy binds us, and we will say no more.

Improving steadily and growing wiser every day, the year felt that the time had come for "a little dance." So, keeping in line with this improvement, the executive secured a most luxurious place, and after much trouble and preparation, the night of nights came, when, with fair ladies, the embryo engineers danced the night away. A dance, at best, is difficult to describe, and as this is not the society column, the description of the gowns will be omitted, and also the "among those present," but, suffice it to say, that there was not one jarring note in the whole evening,—except, perhaps, the bursting of one or two balloons—and that it was with great regret the dancers left for home—and lectures next morning—longing for another "night." This next night came in due course, and served as a safety-valve for much energy gathered in the weeks after the Christmas vacation. The evening was spent at a theatre, and, contrary to the years of many, the "riotous" Freshmen only served to relieve the monotony between acts—much to the joy of the manager. Several representatives of a rival college hockey team happened to be there, and after they had made known their presence, a song of regret and sorrow, sung to an old familiar tune, was rendered for their benefit. This social number was another signal success.

Not in sport alone is 2T4 science engaged, but in almost every School and Varsity activity, from the Glee Club to the Debating Club. Right here, it would be well to mention the part taken in the School Debating Club. Early in the year keen interest was shown by several of the class in this important club. After defeating the Second Year in a lively debate, the finals were entered with the Third Year as opponents. Here again the year scored by winning the shield for debating.

In concluding pardon is asked for any undue conceit, but let us say that no Frosh year has a better outlook or a more friendly feeling, or a better chance to uphold the traditions and reputation of this old Varsity and School.

OSBOURNE.

Engineering Society
ELECTION RESULTS

Engineering Society Executive

President....................................Jack Langford
Vice-President..............................H. M. Morris
Treasurer......................................H. J. Coulter
Corresponding Secretary...................G. M. Crossgrove
Curator...J. W. Reid

Chairmen of Clubs

Civil Club.....................................G. A. McClintock
Mining and Metallurgical......................J. Drybrough
Chemical Club...............................A. E. H. Fair
Architectural Club............................W. B. Helme
Electrical and Mechanical Club (acclamation)..W. C. Duncan
Debating Club (acclamation)...............D. W. Rosebrugh

Athletic Association Executive

President...............................W. Beattie Ramsay
Vice-President..............................M. P. MacLeod
Secretary-Treasurer........................Robert Relyea

Year Presidents

Fourth Year President.............................S. Coulter
Third Year President................................J. Farley
Second Year President.........................J. M. Dymond

Year Athletic Representatives

Fourth Year...K. Greig
Third Year.......................................F. S. Seaborne
Second Year.....................................K. V. Heyland

Students' Administrative Council Representatives

Fourth Year (acclamation)..................H. G. Thompson
Third Year..F. A. Murphy
Second Year (acclamation)...................W. A. Osborne

Permanent Executive of Graduating Year

President (acclamation).............................J. F. Young
Vice-President.......................................J. M. Breen
Secretary-Treasurer (acclamation)..............E. J. Marsh

"School" Y.M.C.A. Executive

President..T. S. Glover
Vice-President.................................J. W. MacIntosh
Secretary-Treasurer...............................L. C. Jackson

S.P.S. DEBATING CLUB EXECUTIVE, 1920-21.

Left to right:—A. S. F. Murphy, 2nd Year; G. P. Sabiston, 1st Year; J. D. Relyea, 4th Year; D. Goldstick, I.C.D.U. Debater.
D. W. Rosebrugh, Secretary-Treasurer; G. A. Brace, President.

S. P. S. DEBATING CLUB

THE S.P.S. DEBATING CLUB has come into its own as one of the leading clubs in School, and a member of the Federated Clubs in the Engineering Society. A membership of over one hundred has proved that whatever engineers have been in the past, they are not now indifferent to the value of public speaking.

The first meeting for the session 1920-21 was held on October 22nd in Hart House, when the election of all the officers but the President took place. This meeting was a get-together one, and each man was given three minutes to speak upon his work during the past summer. Arrangements were made at this meeting for the executive to choose the debaters for the debate against University College, which was to take place in November.

On November 10th a meeting was held to discuss the subject for debate with U. C., which was "Resolved that the principle of self-determination is a false basis for the settlement of boundaries." This proved to be rather an abstruse and uninteresting subject, and we were defeated on November 16th by U. C., which had the affirmative.

On December 14th a meeting was held as a preparation of a limited company. Hon. Mr. Justice Masten, the President of the University Alumni, kindly explained the salient points, and plans were immediately put under way for the floating of the company. At this meeting also Mr. W. E. Bennett, the Curator of the Engineering Society, was appointed our representative on the Engineering Society Executive, with power to award the Engineering Society Cup for the best speaker in "School," and the Segsworth Debating Shield to the successful year in the inter-year debates.

On January 18th the first of the inter-year debates was held, between the First and Second Years, upon the subject, "Resolved that it will be better for humanity if it concentrates its energies upon social reforms rather than scientific progress for the next eighty years." The First Year, who had the negative, were judged to have won.

On January 28th the second of the inter-year debates was held, between the Third and the Fourth Years. The subject was "Resolved that male and female bachelors ought to be taxed more heavily than they are, in order that married men under thirty may be totally exempt." The Seniors upheld the motion, while the Juniors held the reverse view. This debate was very funny, and was judged with great impartiality by a bachelor and a married man. The Third Year won.

On February 8th the largest and most successful meeting of the year was held, when a limited company was formed, known as the "Dynaloids Products' Limited." Extensive advertising

produced a crowd which filled East Common Room, Hart House, to overflowing. Mr. Laidlaw, a School grad. of 1915, and now a lawyer, carried the company through the usual routine meetings in the initial stages of the company's life. The rest of the meeting was planned and carried through solely by members of the Club.

At a Directors' meeting, held about six months after the formation of the company, the by-laws were read, and a special meeting of the shareholders was called as a result of the demands of shareholders holding one-tenth of the subscribed stock.

This meeting was held directly and proved to be a series of startling and disastrous developments for the company. The invention was ridiculed by a prominent engineer, then supported by the supposed inventor, who upheld the soundness of his product. The unexpected appearance of the real inventor, Mr. Borden, of the H. E. P. C., who accused the company engineer of pilfering his invention, threw discredit upon the whole company. An adverse balance in the company's books decided the stockholders to go into an assignment, and an assignee was appointed.

At the assignee's meeting, creditors and employees pressed their claims, and the assignee explained their legal rights. As the assets were not enough to pay the wages, the directors were held responsible for these. One of the leading promoters, while within the law was shown to have used sharp practice in floating a doubtful invention. The shareholders were held responsible for the remainder of the subscription on their preferred stock, and for the full value of the bonus stock.

The talent for public speaking brought out at this meeting was surprising, especially among the First year, and the continued humorous sallies kept the audience in roars of laughter.

For the purposes of promoting interest in the Club, and of actual training for individuals in speaking before a large audience, the evening was a great success. School men usually associate debating or speaking with a dry evening, but this venture proved that such is not at all the case. More of such meetings could be held with profit in the future, but earlier in the year, when the advertising would be of greater value to the Club itself.

The success of the evening was solely due to the co-operation of the members in putting their best into it, and especially of a few members who spent an immense amount of work in planning. The prospectus, printed by the International Nickel Co. of Canada, at great expense and trouble to themselves, proved to be the leading factor in advertising the meeting. The aid so kindly extended by Mr. Laidlaw was invaluable.

At a general meeting of the Engineering Society on February 23rd, a motion of affiliation of the Debating Club with the Engineering Society was passed. This ensures us representation on the Engineering Society in future.

The last, and certainly one of the best meetings of the year was held on February 28th, in the East Common Room, Hart House. The meeting was a double one. The first part was the final inter-year debate between the First Year and the Third. The subject was, "Resolved that the group system of Government is better than the two-party system." The old adage that "History repeats itself" was proved to be false at this meeting, for although the Third Year were successful against the First in the spring of 1920, yet this time the Frosh won, and rightly so, not only on account of the amount of work they had done for the debate in question, but in view of the interest they have taken all year in the Club. To them then belongs the Segsworth Shield for the year.

The Oratorical contest for the Engineering Society Cup was the second part of this meeting. Professor Greaves, of Victoria, judged between the sixteen competitors, and gave many valuable hints to them upon the correction of their style. He awarded the cup to Mr. Brace '21 and Mr. Rosebrugh '22, who had tied After mutual felicitations the Club disbanded for the year.

At the annual School elections Mr. Rosebrugh was elected President by acclamation in recognition of his outstanding ability and unsurpassed services to the Club during the year. I feel that the Club could not be left in better hands.

G. A. BRACE, President.

FACULTY OF APPLIED SCIENCE Y.M.C.A.

THE Y. M. C. A. of the Faculty of Applied Science was organized in 1905, and it forms an integral part of the University Y.M.C.A., which is a Federation of the Association in the various colleges and faculties. During the past year the Association has become affiliated with the Student Christian Movement of Canada, a movement embracing all students, men and women, throughout the Dominion, which is attempting to form a closer bond of federation between the various Christian organizations in the Canadian Universities and to promote Christian work in them.

Membership in the Y.M.C.A. is open to all students in the Faculty, and the Association seeks, through study, prayer and other means, an understanding of Jesus, and invites into its fellowship all students who are willing to test the validity of the conviction upon which the association is founded.

The work during the past year has been carried on under the leadership of F. W. Dunton, President of the Association in the Faculty of Applied Science. Classes were organized to study the life and teachings of Jesus under the leadership of Professor C. H. C. Wright, Prof. J. Roy Cockburn and Dr. Sharman, as

S.P.S.—S.C.A. EXECUTIVE, 1920-21.

F. A. Murphy, J. H. McIntosh; T. S. Glover, C. J. McKeown.
F. S. Spence, F. W. Dunton, Prof. Wright, W. O. Longworthy, A. A. Bell.

well as several groups led by students. These groups have been of great interest and help to the students throughout the year.

A group of those who were interested in Boys' Work and Community Service was organized, and met once a week throughout the year. Prominent men in boys' work addressed the class on problems relating to the 'teen age boy, and an opportunity was given to the members of the group to lead a class of boys during the week.

The Y.M.C.A. has been active not only along lines of study, but in extending a welcome to the first year men. Hand-books containing useful information for the students have been distributed, a rooming list has been kept, as well as a book exchange. At the beginning of the year a reception was held in Hart House for the first year men, at which the aims of the Association were presented to those present.

On the whole, it may be said that the year has been successful, but those who are interested in the aims of the Association are looking forward to a time when all the students will take an active part in the Christian activities of the University.

THE ANNUAL AT-HOME

THE ANNUAL AT-HOME was held on the evening of January the third in Hart House. The marvellous combination of the big gym, the Great Hall, the pool with its soft lighting for sitting out, and the Common rooms as auxiliary dancing floors, could be found in no other building. The lights and decorations were so admirably designed as to put to shame some faculties with more claims to artistic abilities; the much-needed rendezvous of the various clubs were exceedingly novel, while the "Psalm of Life," stretched along the walls, emulated Milton's Areopagatica in the Great Hall. The orchestra, under the direction of Mr. J. Wilson Jardine, entered into the spirit of the evening and provided an excellent programme of the best popular music.

The supper was divided into two sittings, which eliminated much waiting and all confusion. During a supper extra, balloons which had been suspended under the roof, in a huge Union Jack, were released. The scene as they fell, all sizes, colors and shapes, while the spotlights played upon them and upon the dancers beneath, was one of great gorgeousness and beauty. Shortly afterward photos of some of the Faculty's brightest stars were shot upon the screen. These included President Downie, Joe Breen, Gordon Duncan, "Spike" Carruthers and Beattie Ramsey. *Nunc plaudite!*

Eclat was lent the evening by the presence of many members of the E. I. C., who were in town for the Annual Convention, and had been presented with complimentary tickets by the

SCIENCE DANCE COMMITTEE, 1920-21.

Standing:—G. W. Smart, F. W. Dunton, C. B. Macqueen, G. Lindsay, F. S. Spence.
Sitting:—G. V. Rayner, Vice-Chairman; P. J. Culliton, Chairman; R. W. Downie.

Toronto Branch of the E. I. C. Among them were many of the school's younger graduates, and also some of Canada's foremost engineers,—many of them graduates of "School."

Everyone enjoyed the dancing to the utmost, the numbers being well chosen and the lighting effects rich and well balanced. The numerous encores given were sufficient indication of the appreciation of the dancers.

Though the dance was one of unusual size, yet it had the inimitable touch, that air of *bon homie* which always prevails at "School" functions. It was undoubtedly one of the best "At-homes" in many years, and it will linger long as a fragrant memory in the minds of those who were fortunate enough to be there.

THE SCHOOL DINNER

IN each School year, there stand out three major events—the Engineering Society elections, the School Dance and the School Dinner. Of the two social functions, the dinner is probably of greater importance, since it is attended by a larger portion of the student body.

This year witnessed a new departure in the holding of the dinner before, and not after, Christmas, thus removing an important function from an overcrowded term. Also it becomes a greater factor in the early awakening of a freshman's enthusiasm in his faculty.

In planning the Thirty-first Annual Banquet, the Dinner Committee made other changes which added to the success of the evening. The dinner was held in Hart House, the most appropriate place for it. The magnificence of the Great Hall emphasized the importance of the occasion, and its atmosphere fostered an air of closer association with the University as our Alma Mater and not merely as a place to gain a little knowledge of engineering.

Another innovation was the holding of a smoker after the actual meal. The diners moved from the Great Hall to the gymnasium, where the toasts were given. Here also, a short entertainment was offered by a number of the students. This feature engendered a closer and more friendly relationship between student and professor. This feeling is much strengthened by amusements of common interest, a feat which only one address in many could ever accomplish.

The students were practically unanimous in their approval of the excellent work done by the Dinner Committee, and general opinion placed the standard of this dinner above those of previous years. May this improvement continue and each dinner be bigger and better than the one preceding, and do its bit, as the others have done, in animating the spirit of Toike Oike.

SCIENCE DINNER COMMITTEE.

Back Row:—D. MacBeth, A. R. Smythe, S. L. Coulter, J. M. Dymond, A. E. O'Brien, L. F. Stokes.
Front Row:—E. A. Dunn, Secretary; R. W. Downie, P. J. Culliton, Chairman; J. W. Gardner, Vice-Chairman; G. D. Maxwell.
Absent:—H. A. Knight.

RULES FOR FRESHMEN

THE now almost old-time bugbear, the war, has wrought many changes in the old-time traditions of School. Perhaps the most outstanding transformation is the abolition of the ancient free-for-all *melee* between the verbose Sophomores and the verdant Frosh, in favor of our now famous inside initiation.

The old-timers back at School last year looked upon the inauguration of the inside initiation with a great deal of misgiving. They prophesied the decay of the justly famous School spirit. But to the general amazement of all concerned, in the last two years it has laid the foundation of an *esprit de corps* in the first and second years that is equal to, if not greater than, that which existed in the balmy days before the war.

With the return to a normal Freshmen year, next fall, it was felt this year that some extra disciplinary measures were necessary for the benefit and uplift of the young and tender Frosh. A committee to draw up "Rules for Freshmen" was appointed by the President of the Engineering Society, and the following rules were drafted and passed at a general meeting of the Society:

The first group of rules will be enforced during the school year.

1. The first year will supply all fatigue parties required by the Engineering Society Executive. These parties will be detailed by the first year executive.
2. The first year will provide one man daily to report to the President of the Engineering Society for whatever services may be required. (Members of the first year Executive Club and Engineering Society Committee are excluded).
3. The East door of the Engineering Building shall not be used by any freshmen.
4. Freshmen must not wear SPATS or DERBIES.

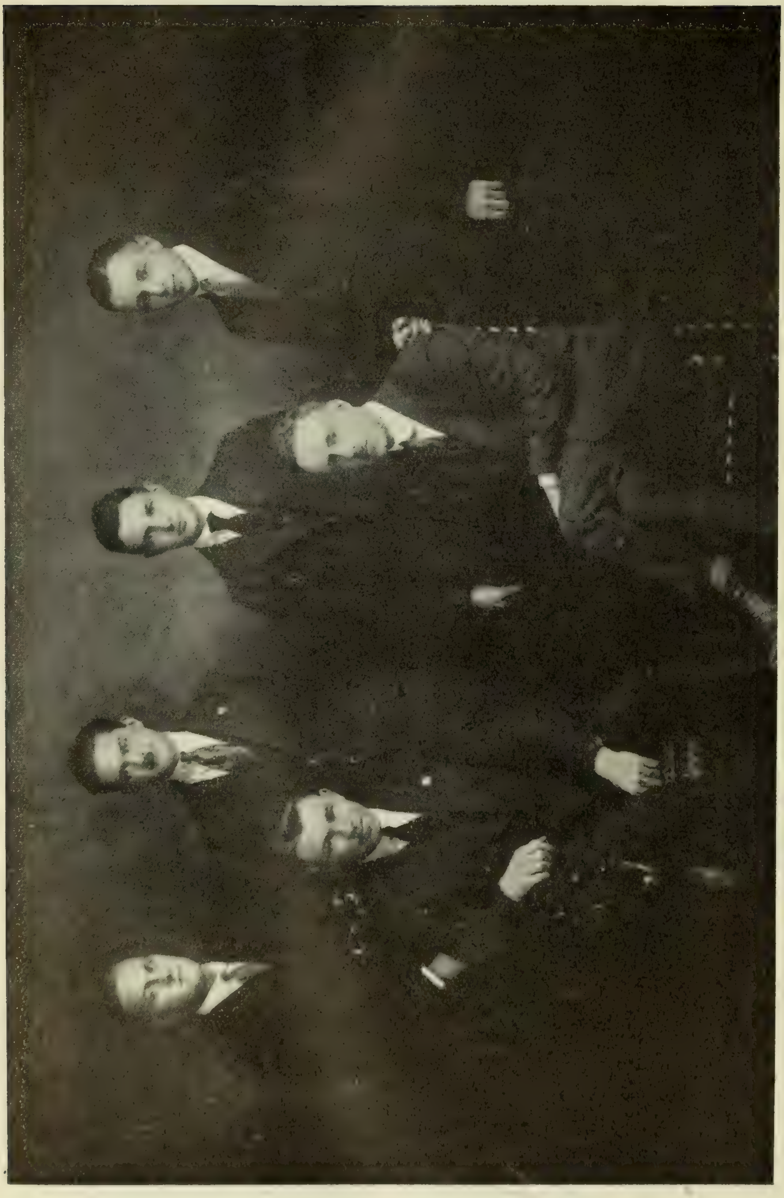
The following rules must be observed up to the time of the School initiation:

1. All freshmen will wear a green tie of the style, approved and supplied by the Supply Department of the Engineering Society.
2. All freshmen will enter the school buildings by the basement doors only.
3. Freshmen will remove their hats in all school buildings.

The initiation will be held the first week in November.

These rules go into effect for the first time next year. As to their success and whether they, along with the inside initiation, will produce the required result is at the present time a matter of doubt—but time alone will tell.

W. E. BENNETT, 2T3,
Chairman Frosh Rules Committee.



SCHOOL OF SCIENCE NGYNYRS SPaSms COMMITTEE, 1920-21.

Back Row:—D. L. Pratt, 3rd Year; J. M. Dymond, 1st Year; R. M. Prendergast, 4th Year; W. D. Jewett, 2nd Year.
Front Row:—D. Macbeth, 2nd Year, Chairman; Craig Hamilton, 3rd Year, Ex-officio.

REPORT OF THE CONSTITUTIONAL COMMITTEE

The President, University of Toronto Engineering Society.

Sir,—Acting on instructions from the Executive, this Committee has carefully studied the old Constitution and herewith beg to submit to the members a draft of the revisions we have seen fit to make. We trust that these will meet with the approval of the members of the Society.

The following are the more important changes made:—

1. The arrangement of sections has been somewhat changed and they now appear in proper order.
2. Various articles have been changed to a different section.
3. Fee for life members has been done away with.
4. Representation on *Varsity* staff is left to the discretion of the Executive.
5. All references to a Permanent Secretary, Manager or Editor-in-Chief have been deleted due to discontinuation of the publication of *Applied Science.*
6. Provision has been made so that the federation of clubs may be extended to include all "School" activities.
7. Provision has also been made to financially assist the clubs if necessary.

The aim of the Committee has been to make the Engineering Society more united and thus strengthen its hold on all its members.

The thanks of the Committee is extended to the Faculty Committee on Engineering Society affairs for their constructive criticism of this effort.

J. F. YOUNG,
Chairman, Constitutional Committee.

Committee

R. W. Downie,........................President of the Society
J. F. Young..Chairman
J. Farley...Recording Secretary
A. L. S.Nash.........................Third Year Representative
C. S. Sneyd,............................First Year Representaive

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THE STUNT NIGHT COMMITTEE EMBODYING THE PRODUCTION OF "SPASMS" BY THE NGYNYRS

Organization

THE ENGINEERING SOCIETY EXECUTIVE appointed as a nucleus for a Stunt Night Committee the following men:—H. G. Thompson, III. Yr., Ex-officio Chairman; D. MacBeth, II. Yr., Chairman; C. Hamilton, III. Yr., Ex-officio.

During the fall term the rush of events claimed the attention of the student body to such an extent that it was only possible for the above-mentioned officers to complete a committee.

At first the conception was a Central Committee on which

would be a Chairman and a representative from each year, who in turn would be the Chairman for a year Committee.

The Central Committee was augmented accordingly by the following men, who were to be Chairmen of their year sub-committees: IV. Yr., R. M. Prendergast; III. Yr., D. L. Pratt; II. Yr., W. D. Jewett; I. Yr., J. M. Dymond.

The sub-committees, however, never materialized, owing to the fact that the departments were too isolated, and a representative year committee was impossible.

Forthwith the Central Committee proceeded to canvass the years through the year representatives, with the result that a programme was prepared. At this stage the Committee were brought to an abrupt stop. The organization of the Stunt Night Committee was *not* one which permitted the production of a show, therefore the producing of "Spasms" passed from the control of the Stunt Night Committee to the hands of the staff of the Ngynyrs. The staff was as follows:—Director and Stage Manager, C. T. Carson, II. 6; Musical Director, C. Hamilton, III. 6; Business Manager, D. MacBeth, II. 6; Master Electrician, A. Wilson, IV. 7; Master of Properties, S. T. Franks, II. 7.

Production

(*a*) **Staging**—The question of the hall was primary. Hart House Theatre was too small, as the intention was to run the show but one night owing to the late date set, March 2nd. Convocation Hall is absolutely unfitted for the production of any event which requires scenery. Massey Hall seemed to be the ideal place. True, there would be expenses in connection with it, but then, the understanding was, that as long as "Spasms" paid for itself, the choice of a hall at any price did not matter. Accordingly, Massey Hall was engaged.

Due to the fact that there was little time for rehearsals, Mr. Carson, the Director, felt the need of assistance on rehearsing and producing the show, whereupon Mr. Thomas McKnight, a well-known director, was engaged.

Some of the skits required properties and costumes. Wherever possible, the Business Manager and Properties Master obtained these from local firms in return for advertising space.

All costumes which could not be obtained otherwise were hired.

Scenery was obtained at a flat rate from Mr. Chas. Gallagher of the Royal Alexandra Theatre. He also supplied two men to handle, install and remove same.

(*b*) **Business and Advertising**—Business policy was to keep expenses as low as possible. To do this, advertising on the programme was given as payment for as many "properties" as possible.

Advertising was handled through *Varsity* to the students, and through the E.I.C., A.S.M.E., A.I.E.E. outside of the Uni-

versity. No advertising was done through the local papers, on the assumption that the returns would not justify the expenditure. More concentrated effort was made to reach graduates and professional engineers, which brought better results, since the invitation to attend was personal. Since this was the first "Spasm," complimentaries were sent to the "School" professional staff to ensure their attendance, and to let them observe that the students had not spent their time in vain.

Treasurer's Report.

Expenses—

Massey Hall	$198 13	
Scenery	75 00	
Mr. McKnight	50 00	
Printing (Programmes)	40 80	
Varsity Advertising	30 75	
Printing (Tickets)	11 35	
Photo Engravers	5 87	
McKenna, costumes, wigs, etc	5 05	
Cartage, Mr. Wilson	34 25	
	7 00	
Cartage and skit, Mr. Hamilton	3 65	
2nd Year skit and music, D. McBeth	9 75	
Trimmings, Mr. Franks	7 65	
Music—Mr. Maunder	95	
Music—Mr. Hamilton	1 00	
Hipp.—Services—Mr. Carson	5 00	
		$486 20

Other Expenses—

Feb. 8—Envelopes, O. D. J	30	
Feb. 10—Signs—McBeth	2 00	
Feb. 13-25—Stamps, O. D. J	16	
Feb. 15-16—Car fare, McBeth	45	
Feb. 17, 19, 25, 26—O. D. J	45	
March 3—Franks	1 00	
March 8—O. D. J	25	
Feb. 26—Tip, Sec. Office Boy	25	
Feb. 26—Comp. tickets tax	2 20	
Cheque book	25	
Music, Mr. Grant	1 70	
Cartage—Supt's. Office	75	
Cartage, Mr. Moore	4 00	
		$ 13 76
		$499 96
Refund from Mr. Franks		1 00
		$498 96

Tickets Sold—

Massey Hall	25	
Engineering Society	820	
Engineers	125	
Hart House	36	
By different members of Committee	15	
	50	
Mr. Dugal (Money left at Eng. Soc.)	10	
Mr. McManus (extra)	4	
		1085

Complimentary—

Staff and members	60	
Press	12	
Orchestra	44	
Cast, Committee, etc.	142	
		258
		1343
Tickets exchanged		1301
Tickets unexchanged	42	

Received from Sale of Tickets—

Mr. G. T. Clarke	$ 27 50	
Mr. Ambrose	3 00	
Mr. Mullins	5 00	
Mr. Roberts	9 50	
Mr. Muir	6 50	
Mr. Caldwell	10 00	
Mr. Hamilton	1 00	
Massey Hall	12 50	
Hart House	18 00	
Sold O. D. J.	7 50	
Mr. McBeth	25 00	
Mr. McManus	2 00	
Engineering Society	349 00	
Engineering Society	66 00	
		$542 50
Expenditures		499 96
		42 54
Refund		1 00
Surplus		$ 43 54

All the items are not covered by receipts, but the main ones all are. You will note that there is a surplus of $43.54, which amount I have turned over to the Engineering Society.

J. L. JOHNSON, Treasurer.

Summary

In summarizing the report, perhaps it would be well to remark on the various difficulties encountered, and the solutions arrived at by the staff. These are:—

(1) **Time**—The time for the production of "Spasms" in the future should logically be the Fall term. Then the student body is more willing to lend time and effort to an endeavor than at any other time. Therefore, we strongly advise that in the future "Spasms" be a fall term event and the production of "Spasms" in the fall term should make it a 50 per cent. better show.

(2) **Localism**—Every endeavour was made to prevent "localism." It is the curse of the amateur production, and what could be more boresome to a gathering of graduates at an Alma Mater event than the production of a whole show based on localism of which they know nothing?

(3) **Tickets**—We strongly advise that in the future all seats be sold *without reservation by years.* The following reasons may satisfy the arguments for such a procedure as was followed this year:

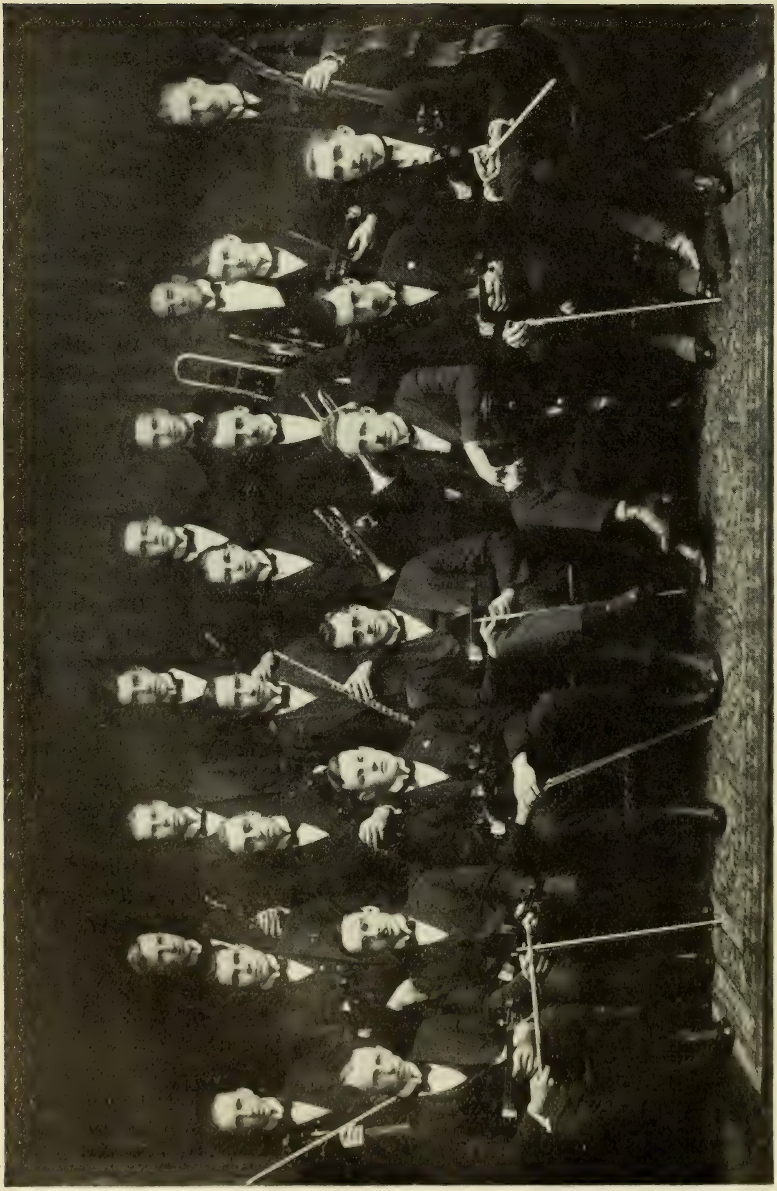
(*a*) Those desiring seats together merely gave their tickets to a single individual who obtains a block of seats together.

(*b*) The exchange ticket system which was used this year permits the above.

(*c*) Those to whom the best seats were forthcoming this year had the poorest. For instance, the 4th year were at the rear downstairs.

(*d*) Perhaps the best policy would be to give to the graduating year the privilege of a block of the best seats in the house reserved. Then the others could get theirs by block system through exchange tickets. The quality of their seats being influenced only by their desire to see the show. If one desires to get good seats under the Open House Exchange Ticket System, one only needs to secure those seats early in the seat sale. The policy to award to the graduating year a block will come to each year in turn, and so favor no one.

(4) **Awarding the Cup**—In awarding the cup for the best skit this year difficulty was experienced in securing the dramatic critics, owing to the fact that their tickets were mislaid. Consequently, an adequate criticism was not available. However, we feel that we have scored this year the best faculty stunt night staged, and we recommend that "Spasms" be continued along the lines of a revue, for the simple reason that the experience gained by the participants will be more in the line of real stage experience, and in so doing the tendency will be to produce a *whole show,* rather than a number of "local" skits. The advan-



TOIKE OIKESTRA, 1920-21.

Back Row:—P. S. Davidson, J. J. Crawford, H. F. Robertson, R. R. Parker, M. L. Rundle, Treasurer; F. J. Lavender.
Centre Row:—R. K. Scott, G. A. Thompson, H. R. Fardoe, T. M. West, Secretary; G. H. Voaden, Librarian; P. S. Edwards, L. J. Bonham, J. Buchan.
Front Row:—H. A. Jackson, J. R. Kirkconnell, S. R. Muirhead; G. D. Maxwell, C. Hamilton, President and Conductor; H. G. Thompson, J. S. Mayberry.

tage of this tendency lies in the fact that the show becomes one which will appeal to graduates as well as undergraduates.

Therefore, we strongly recommend that the cup be given for skill and execution of parts rather than for *subject matter*, and in so awarding the cup—all secret rehearsing will be eliminated, and the show can be rehearsed and directed by a Director—tending to give a better rehearsed and more cohesive production.

(5) **Productions Staff**—We recommend that instead of a Stunt Night Committee, a Spasms Professional Staff be appointed directly by the Engineering Society. A Committee would be forced to organize a production staff in any event, and the intermediate committee is unnecessary. We submit the following "Production Staff" outline for "Spasms II.":

Professional Staff of "Spasms"—Director and Stage Manager, Assistant Stage Manager, Business Manager, Publicity and Advertising Manager, Musical Director, Master of Properties, Electrician, Treasurer.

In closing our report we beg to submit that our "Summary" with suggestions, is only introduced in the text of the report because of the fact that the matters considered are the chief difficulties encountered in breaking the road to an annual "Spasm," and we wish to pass on these observations as the result of experience, in the hope that they will be of use to the Productions Staff of "Spasms II."

TOIKE OIKESTRA.

THE conclusion of the session 1920-21 brings to an end the second year of the orchestra's work since its reorganization following the war. On the opening of School last fall little time was lost in getting under way, and practices were commenced, under the leadership of Mr. C. Hamilton. It was found that there were about twenty men in the various years that were willing to give their time and talents to this branch of School activity. Practises were continued regularly throughout the year, and it is only fair to say that, to a large extent, the success of the orchestra is due to the faithfulness of the individual players in turning out to these rehearsals.

At the organization meeting the following executive was elected: President and Conductor, Mr. C. Hamilton; Secretary, Mr. T. M. West; Treasurer, Mr. W. L. Rundle; Librarian, Mr. G. Voaden. The brunt of the work fell on Mr. Hamilton, and the thanks of the orchestra are due to him for the way in which he took charge.

The orchestra, besides playing at Engineering Society meetings when required, performed at the following functions during the course of the year: Engineering Alumni reception and dinner, Engineering Society dinner, E. I. C. smoker, Farmers' Winter

Course dinner, concert given at St. Paul's Methodist Church, and "Ngynyrs Spasms." It was at the last named that the orchestra scored its greatest triumph, and demonstrated to the public what it really could do. The greater part of this work was done gratis, but one or two donations were received for the orchestra fund.

The nature of the work the orchestra was called on for was mostly of the light, popular variety, but for the concert given at St. Paul's a higher standard of music was provided.

Those in charge would also like to take this opportunity of thanking the Engineering Society for the backing that they have given the organization. Through their generosity the orchestra have been able to procure a set of drums and a number of music-stands of their own that has greatly facilitated the work and increased the efficiency of the organization.

THE SPaSms CUP

To promote a healthy spirit of rivalry between the various groups presenting sketches wth the NGYNGRS in their annual SPaSms, the Engineering Society have donated a handsome silver cup, suitably engraved, as a perpetual challenge trophy. Realizing the merit of single or team performances, they have this year instituted the practice of donating a prize for the best of these. The individual prizes, which took the form of gold-filled lockets with the School pin set thereon, were won by Messrs. Grant and Walker. The Committee of judges, after a considerable amount of deliberation, awarded the trophy to 2T2 for their "Krazy Cabaret."

The following are the rules for the competition as drawn up by the Executive:—

The Cup shall be a perpetual challenge cup to be held by the Year or Club presenting the best number with NGYNYRS in SPaSms.

The award shall be based on the following conditions:—

(*a*) The cast shall consist of three or more performers.

(*b*) The general excellency of the production rather than the originality of the dialogue shall be the object sought.

(c) The contestant shall at all times comply with the instructions of the officials, such as stage manager, censor, etc., appointed by the Executive.

(*d*) The Executive shall appoint annually a board of at least three judges of which the President of the Society shall be one.

(*e*) In case of dispute the President of the Society shall decide on the correct interpretation of these rules.

The individual prize or prizes shall be awarded to the best number put on by not more than two performers, and shall take such form as the Executive shall decide.

SCHOOL OF SCIENCE HOLDERS of "T's"—1920-21

Insets:—W. B. Ramsay, '22, Hockey (Capt. '20-21). A. W. Carew, '23, Rugby.

Top Row:—K. L. Carruthers, '22, Track (Capt. '21); C. A. Hughes, '20, Rugby; G. E. Lindsay, '23, Swimming, (Capt. '20-'21); J. R. Gilley, '21, Soccer; M. D. Earle, '23, Rugby; F. C. A. Houston, '22; Rugby; G. R. Gouinlock, '21, Hockey; A. A. Bell, '23, Rowing.

Centre Row:—J. C. Perry, '22, Wrestling; G. F. Evans, '22, Hockey; J. B. Hamilton, '21, Rowing; F. R. McDonald, '21, Pres. S.P.S. Ath. Assoc.; Prof. C. H. C. Wright, Hon. Pres. S.P.S. Ath. Assoc.; F. S. Seaborne, '23, Boxing; H. S. Spencer, '21, Tennis; W. J. Nichol, '20, Hockey.

Bottom Row:—G. L. Magee, '21, Rowing (Capt. '20-'21); W. S. Sherk, '22, Wrestling; G. G. Duncan, '23, Rugby, Capt. '21); J. M. Breen, '21, Rugby (Capt. '19-'20); R. D. Heustis, '20, Gymnasium; G. R. Workman, '10, Gymnasium; P. F. McIntyre, '21, Hockey; E. G. Rolph, '23, Rugby.

APPLIED SCIENCE AND ENGINEERING ATHLETIC ASSOCIATION EXECUTIVE, 1920-21.

Back Row:—J. G. Johnston, 2nd Year Representative; J. C. Perry, 3rd Year Representative; W. J. Parker, 4th Year Representative; W. S. Shirk, Secretary-Treasurer.

Front Row:—F. R. McDonald, President; T. R. Loudon, Hon. President; G. G. Duncan, Vice-President.

SCHOOL ATHLETICS, 1920-21

By F. R. McDonald, *President Athletic Society.*

Executive for 1920-21

President	F. R. McDonald
Vice-President	G. G. Duncan
Secretary-Treasurer	W. S. Sherk
4th Year Representative	W. J. Parker
3rd Year Representative	J. C. Perry
2nd Year Representative	G. Johnson
1st Year Representative	Littlejohn

SCHOOL has had an extremely successful year in the sporting activities of the University. Every Varsity team has had a large percentage of School men on it, and the old School spirit was never more predominant than it has been this year. Two Captains of Senior teams spend the rest of their time chasing knowledge at the old red schoolhouse, namely Joe Breen, Rugby; Beattie Ramsay, Hockey, and for next year we have G. G. Duncan as Rugby Captain and K. L. Carruthers as Track Captain.

No less than five championships were won by School this year, namely, Track, indoor and outdoor; Soccer, Rowing and Swimming. These five represent about half the inter-faculty sports of the University, and our teams in the Hockey, Rugby, Basketball, and other series all gave a very good account of themselves. Our Indoor Baseball team at the present is on top, and look like champions for this year.

School Athletic Executives have always labored under the difficulty of having to collect a voluntary athletic fee from the students, which has always been inadequate to properly carry on the work. This year's Executive, in co-operation with the Engineering Society, took a referendum vote on the matter of collecting a compulsory fee of $1 at registration from every student. This was carried by a majority of over 500, and the recommendation passed into the Faculty Council's hands, where it will, in all probability be sanctioned and thus come into force next session. This will give the incoming Executive, headed by Beattie Ramsay, about $800 to run affairs on, whereas this year we had approximately $400.

The Athletic Society is now one of the affiliated clubs of the Engineering Faculty, and hence the President is a member of the Engineering Society Executive.

It was thought probable that some friction might arise in future between the two Societies, so the Engineering Society Executive introduced a section XI. in their constitution whereby the Athletic Society has absolute control of its own affairs.

It is evident, then, that the Athletic Society benefit alone by this affiliation and it should also help to raise the status of the

Society in school life to the point where it should be.

In closing, on behalf of the Executive of 1920-21, I wish to thank you all for your support this year, and wish my successor, B. Ramsay, and his Executive, all possible success for the year 1921-22.

F. R. McDONALD, President, Athletic Society, 1921.

Rugby

No sport at the University has had the same influence in developing the physical side of the students as has Rugby. It is a game where one must be absolutely fit to be a success, and long and strenuous training is necessary to make one so. Perhaps no other game requires such strict training rules as does Rugby. That these rules are beneficial to the physical side of our beings is quite evident from an inspection of Rugby devotees.

Joe Breen

The number of students at the University taking part in this sport runs into the hundreds, and there is plenty of room for all who care to play.

Last year there were in the neighborhood of one hundred candidates for the first and second Varsity teams.

The success of last year's Varsity team was largely due to the capable coaching of Laddie Cassels. He worked tirelessly day after day to round out a team that would be victorious, and his efforts were crowned with a well-deserved success. The Varsity team's strongest feature was their team-play, which was developed to the very highest.

The season of 1920 was a very successful one for the University of Toronto Rugby Club. The Senior team won the Intercollegiate Championship and the Dominion Championship, and the Intermediate team also won their Championship in the Intercollegiate.

In the Senior Intercollegiate series, McGill and Toronto were tied, and a play-off was necessary. This took place at Kingston, and Varsity were returned victors by a score of 16-6.

In the Dominion Championship Series, Argos and Varsity met in the finals, and Varsity won by a score of 16-3.

The Intermediates defeated Queen's in the final home-and-home series by a good margin, and their honors were well earned.

"School" put two teams as usual into the Interfaculty Rugby Series. While neither of these teams got into the finals, yet they gave a splendid account of themselves, and put up some grand games.

The Championship and the Mulock Cup went to Victoria, who defeated Senior Meds. in the finals.

That School failed to go farther in the Mulock Cup Series is, however, no disgrace. Her best players went to form part of the first and second Varsity teams, and thus her Mulock Cup teams were weakened.

Six of the 1st team regulars were School men,—Gordon Duncan, Ernie Rolph, "Tiny" Houston, "Happy" Earle, Artie Carew and Joe Breen. Quite as good a representation of School men were on the 2nd team.

However, this sacrifice was a willing one. To the honor of School and in exemplification of "that School spirit,"—now known all over the University,—we still say "Varsity first,—Faculty second."

"JOE" BREEN

Hockey

"School" in hockey has acquitted herself nobly, having representatives on all three Intercollegiate teams, besides the two teams entered in the Jennings Cup series.

Everyone is cognizant of the success of the Varsity Senior team in both the O.H.A. and the Intercollegiate series. Of the total number of players on the team Ramsay (Captain), Sullivan and McIntyre hail from the little Red Schoolhouse. In all the team played thirty games, losing eight, three of these being exhibition games. In the Intercollegiate series the team won all four games, winning the Intercollegiate senior trophy for the sixth time since its donation by the Queen's University Hockey Club.

The O. H. A. schedule was a much harder contested affair. Varsity, having lost two games early in the season, were forced to win their final four games to qualify for the play-off with Granites for the J. Ross Robertson Memorial Cup. It was conceded by hockey critics that this was almost impossible, but, backed up by the good old Varsity spirit, 100 per cent. pure, they achieved the "impossible," earning the right to be known as the "Iron Men."

In the Allan Cup semi-finals Varsity played three games, winning all by a good margin. In the finals, played at Winnipeg on March 19th and 21st, the first game was lost to Brandon by a score of 2-0. This game was played on soft ice, which handicapped the lighter and faster Varsity team. In the second game, played on hard ice, Varsity justified the confidence placed in them by their supporters, by romping home on the long end of an 8-1 score, thus bringing the Allan Cup back to the East with a good margin of five goals.

S. P. S. was well represented on the Intermediate team by H. L. McCulloch (Captain), G. A. Thomson, F. R. McDonald, G. F. Evans and H. J. D. Wilford.

This team won their groups in the Intermediate Intercollegiate and Intermediate O.H.A. series. In the former they were

UNIVERSITY OF TORONTO HOCKEY TEAM, 1920-21

Standing:—J. H. Langtry; N. Lang, Trainer; F. R. MacDonald, Secretary-Treasurer; P. F. McIntyre, President; G. E. Westman; J. O. Olson; Dr. J. W. Barton, Physical Director; C. Smythe, Honorary President; J. T. A. Sullivan.
Back Row, Sitting:—Dr. A. B. Wright, Honorary President; Stan. Brown; W. B. Ramsay, Captain; W. J. Carson; Dr. W. A. Dafoe Honorary Coach.
Front, Sitting: E. N. Wright; F. G. Sullivan.

beaten in the finals by Queen's University by the small margin of one goal, while in the latter series they were defeated by Belleville in the second elimination round.

In the Junior series "School's" representative on the team was "Steve" Grey, of U.T.S. fame. This team was successful in winning the S.P.A. Cup, but in the O.H.A. series, after tying their group with De La Salle, lost out in a very stubbornly contested game. In the Intercollegiate play-off with Queen's University they tied their round, but in the play-off at Trenton were unsuccessful in their clash with the heavier Queen's team.

The season just past has been the most successful Canada's great winter sport has ever had. U. of T., in winning the premier honors, has much of which she may well be proud, and "School's" contribution to these honors has more than upheld the traditions of the "Old Red Schoolhouse."

Basketball

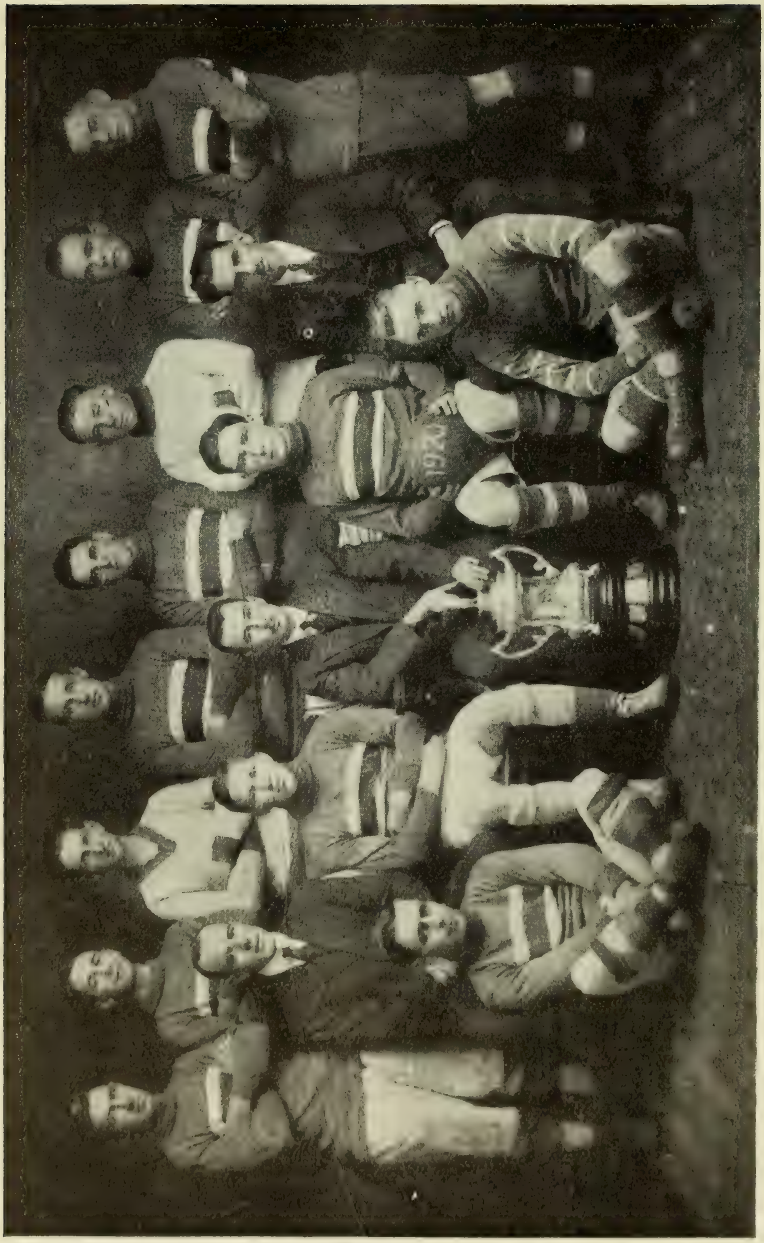
For another year basketball is on the shelf, and School has failed to win the much-coveted Sifton Cup. If one had asked the Manager at the beginning of the season, what calibre of a team School would have, he would have told you a winning team. Now is no time for alibis, but why did School not win the Cup?

At the first of the season there were two chaps, Henderson and McLean, in their first year, who were well known in the basketball field. Due to some difference of examination, Henderson left School about the 1st of November, and went to Queen's University, where he played on the Intercollegiaate team of that University. McLean fared a little better, and stayed with School until the latter part of January. These were very serious losses for the Junior School team, and there is no doubt in Captain Jennings' mind that if School had been able to keep together the team that turned out at the first of the season, all would have been well.

In this article the team would like to thank the followers and supporters of the team for the way they turned out to the games. Still, they feel that if there had been a few more "Toike Oikes" in those crucial games against Dents, the tables might have been turned.

It must be remembered that the chaps who have been playing on the Junior School Basketball team are not one-sport men. In the fall, Johnston, Jennings, McBride and Hyland were playing rugby for Junior School; Meredith was on the track team, and Bell rowed in the Varsity eight.

Before the first game, Jennings of second year was chosen as Captain by the team. In selecting Jennings for this position, the team chose a man who takes as great an interest in interfaculty sport as any man in the School. For the past two seasons



SCHOOL OF SCIENCE SOCCER TEAM—INTER-FACULTY SOCCER CHAMPIONS 1920.

C. P. Breuls, W. V. Bishop, J. H. Browne, C. H. Lucas, L. D. Campbell, J. MacLellan, R. H. B. Cook, T. S. Glover; S. S. Smillie, Secretary; J. S. Morrish, S. W. Archibald, President; H. F. Wingfield, Captain; N. F. Johnson, Manager; E. S. Learoyd, W. R. Dunbar.

he has been playing on the Junior School rugby and basketball teams.

Junior School were grouped with Senior Meds, Junior Dents and Pharmacy. In the first game against Pharmacy School won by a one-sided score. The second game, which was with Junior Dents, was a nip-and-tuck affair. This was the only game McLean played in, and he showed up a star by scoring ten out of School's twelve points. The final score was 13-12, with School one point down. In the next game against Senior Meds, School won very handily, and the same punishment was meted out to Pharmacy. Then came the final game with Junior Dents. With the loss of McLean, the team knew they were in for a battle. From the first whistle School battled hard and were leading by one point, with one minute to go, when Dents scored a field goal, which won the game 11-10. The last game with Senior Meds was easily won by School.

Though this year has passed somewhat uneventful for the School basketball teams, we must look now for the material for next year's team. The defence players of this year were all first year men, and were the best defence School has had for a long time. A new forward line will have to be built up, as most of the men in those positions will be playing for Senior School.

It would be advisable for the men who intend to play basketball next year, to turn out with the Intercollegiate teams. This would give the players a good month's lead on the other teams, and it would also help make the Intercollegiate basketball teams a little more representative.

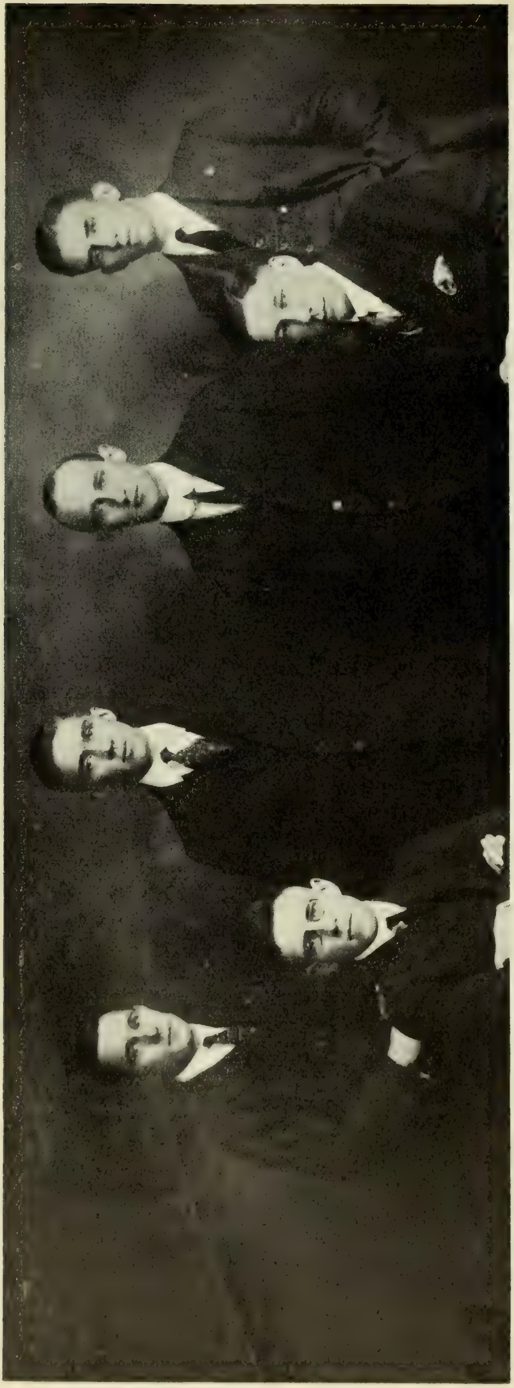
But let's look on this from the bright side. Let every man in School back the basketball team, so that next year, with the increased experience and knowledge gained by the players, we may bring home the Jennings Cup. The team: Forwards, Jennings (Captain), McBride, Meredith, Johnston; centre, Bell, McMillan; defence, Shields, Hyland, Gorky.

Soccer 1920-21

When reviewing the athletics at Varsity during the past year and taking stock of the "silverware" which Science teams have won in the many branches of sport, it is well to remember the soccer team, which relieved the Dentals of responsibility for the Faculty Cup, and brought it back to its former place at School.

The schedule for last season divided the faculties into two groups: Meds, Victoria, Wycliffe and Science forming one, and Knox, Pharmacy, Veterinary, with Dents, last year's champions, in the other group. University College did not enter a team.

In their group Knox won out, playing some fast games, but managing to come out first in them all. The Science team also claimed the same record, so there was little to choose between



SCHOOL OF SCIENCE TRACK TEAM, INTER-FACULTY CHAMPIONS, 1920-21.

H. A. Oakes, G. Rumble G. E. Steel, H. J. Meredith,
H. R. Burton (Capt.) K. L. Carruthers (Mgr.)

the two teams when they met in the finals for the cup. The first game of the finals was an exhibition of as fine soccer as has been seen in the series since the war. Both teams worked hard for the full sixty minutes, but School managed to come out on the long end of a two-to-one score. In the second game School elected to play a defensive game, and although hard pressed at times, succeeded in maintaining their one-goal lead by a no-goal game, thus winning the round and the cup.

As in all sports, Science supplied a full share of men for the Senior and Intermediate teams, there being three on the Senior and seven men on the Intermediate. The Senior series was short, there being only two games played, one at Kingston, which resulted in a tie, and one here, when Queen's were defeated, giving the championship to Toronto. The Intermediates played a series with McMaster, City Teachers and O.A.C., and by defeating O.A.C. on the back campus by a one-nothing score, proved that they were the best.

The season was productive of a class of sport in all three series which should go far to bring soccer back to the position it once occupied as one of the foremost sports at Varsity. Next season it is expected that Varsity will put a team in the T. and O. Cup finals. The games will be played at the Stadium, and should fill out the season and arouse some much-needed enthusiasm throughout the University. In the inter-faculty series, too, there is promise of keen competition. It will remain to the Junior years of School to turn out men who will fill up any gaps in the ranks of last season's team, and produce an eleven which can show our motto, in so far as the Faculty Cup is concerned, to be, "What we have we'll hold."

Track and Field—Harrier

The year 1920-21, as far as the track team is concerned, has ended in a blaze of glory, and left the mantle of victory resting securely where it belongs, on the shoulders of the School of Science men.

Continuing their double victory of last year, the School track men pulled off a win in both the outdoor and the indoor inter-faculty contests. The outdoor meet was a fight from start to finish, our old rivals, the Meds, running us close. The great work in the sprints of Joe Breen and Rumble, ably assisted by Meredith, McIntyre, Burton and Steel in the field events, saved the day. S.P.S. were without the services of last year's individual champion, who was unable to compete, owing to injuries in rugby.

The indoor meet did not bring out so many School men, but two or three of the old guard turned back all opposition, winning half the events, the individual championship, and breaking four records in addition. Arts gave us a great battle here, too,

and were only four points behind at the end of the season.

The Intercollegiate meet in the fall went to McGill for the second time in succession. The School men on Varsity's team included Breen, Meredith, Steele, McIntyre and Carruthers; but even with their aid Toronto found that McGill had a better-balanced team. Oddly enough, the events Varsity captured in 1919 went to McGill this time, and vice versa.

The track chances for next year are bright. School and Varsity lose several stars who graduate, but younger men are developing rapidly. Nearly all the candidates for our team next year have promised to get off to an early start by turning out by September 15th.

In distances above 220 yards School is weak, so it is no surprise to find Meds winning the Interfaculty Harrier Meet, and providing, with the addition of Leigh of Wycliffe and Stevenson of Dents, the team which so handsomely beat McGill in the Harrier Meet held here. These men are in their junior years, and we should win the Harriers for the next two or three times, at least.

Tennis

Since the war, tennis, like other sports, has flourished, and its popularity is shown by the entries in the undergraduate tournament which have numbered well over one hundred. The year following the war saw Varsity represented by an exceptionally strong and well-balanced tennis team of six men at the Intercollegiate Tournament in Montreal. The U. of T. racket-wielders showed their superiority by winning the tournament by a wide margin. During the last college year, however, McGill was able to put in the strongest tennis team which probably ever participated in a Canadian Intercollegiate tennis championship, with the result that although the Varsity Tennis Team was a very strong aggregation, the McGill team won the tournament.

The under-graduate tournament was held early in October at the Rusholme Lawn Tennis Club, Dovercourt Road, and was handled very successfully, although there were over one hundred entries in the singles and over sixty in the doubles events. The team was chosen from the semi-finalists in the singles and doubles, with the right of any player who had been eliminated to challenge a proposed member of the team for his place on the team. The tournament resulted in the defeat of Wales by Richardson in the finals. Some excellent tennis was the result, and the team finally chosen was made up of Sheard, Spencer, Richardson, Allen, Wales, Phillips, and Williams. Especial mention should be made of the playing of W. Crossen, who, in his first year, reached the semi-finals by playing consistent tennis and defeating several experienced players.

The Intercollegiate championship was held the following

week at Rusholme Club, Varsity's opponents being Queen's and McGill. On the McGill team were two very brilliant players who carried all before them, and after some splendid tennis, the championship went to McGill.

Swimming

In Swimming, as in all other branches of sport, the reputation of the Science Faculty was creditably upheld. Besides winning the Interfaculty Swimming Championship, School had four men on the Intercollegiate team, and five men on the Intercollegiate Polo team. Swimming is getting back to its own at Varsity, and it is our Faculty that is doing the most to put it there. To help the swimming movement, the Fitzgerald Trophy for interfaculty competition was presented to the University this year.

School had strong teams in the Water Polo series and the Swimming meet. Although playing a superior brand of ball, they lost by the narrow margin of two goals in the final polo game with Dents. But in the Swimming meet the results were reversed, the Science team winning more points than the combined scores of their two nearest rivals. George Lindsay broke one record at this meet when he romped away from Frank Wood in the 100-yards speed.

The team:—George Lindsay, 2T3, Captain of the Intercollegiate and School teams; 1st in the 100 yards, tied for 1st in the 50 yards; Toronto's fastest sprint swimmer. H. Keffler, 2T4, tied for 1st in the 50 yds; 3rd in the 100 yards; Ontario 100-yards champion (won at West End, March 19, 1921). C. Harston, 2T3, Captain Intercollegiate Polo team; 2nd in the 200 yards, and 1st man on School relay team. A. Fitzgerald, 2T3, left forward Varsity Polo team; 1st in 50 yards breast. C. Wells, 2T3, Manager School Polo team; defence player Varsity Polo team; 1st 200 yards; Ontario 220 yards champion (won at Central, Feb. 28, 1921.) These men also played in the School Polo team. G. Mutch, 2T3, 3rd in Diving Contest, although handicapped by not having practised. A. A. Bell, 2T3, goal-keeper for the Intercollegiate and School teams; probably the best goalie in Canadian water polo. J. Langford, 2T2, Matson, 2T4, and Schinbein, 2T3, were the other three men who represented School in the Water Polo series. The last-named accompanied the Varsity Polo team to Montreal.

Rowing

In the fall of 1919, Prof. T. R. Loudon, probably the greatest authority on rowing in Canada, and one of the most famous of Argonaut coxswains, considered the possibilities of directing the U. of T. after new championships in sport. The only rowing

S. P. S. EIGHT-OARED CREW.

Winners Inter-faculty Rowing Championship, October, 1920.

Standing:—B. Ramsey (3), J. H. Browne (Bow), J. A. Langford (6), D. M. Ross (4), R. M. McCabe (7), M. Wolsey (2).
Sitting:—H. M. Morris (5), F. A. McDonald (President), Prof. T. R. Loudon (Coach), G. L. McGee (Cox), A. A. Bell (Stroke).

requisites that Varsity possessed was Prof. Loudon's knowledge of the game and the spirit that brought the Grey and Allan Cups, among other championships, to Hart House. With this end in view, Prof. Loudon talked the matter over with three Argonauts, who were undergraduates, and it was decided to call a general meeting to see what could be done. The result was that Varsity now holds the rowing championship of Canada and the Hanlon Memorial Trophy is parked at Hart House among the other championships.

Every race in which a Varsity crew was entered, they won. A four-oared 140-pound crew, Coventry and Tufford of Meds and Hamilton and McGee of School, defeated everything in their class at the Dominion Day regatta on July 1st, 1920. A Junior four (heavyweight) won the final in their event, and incidentally broke the record. Geoff. Beatty of Arts was the original stroke of this four, but he unfortunately took sick a week before the race, so Strathy Hay, the stroke of the Olympic four, replaced him. The remainder of the crew were all School men—Boyd Little, Slim Bell and Doug. Huestis. Another Varsity heavy four, composed of Creighton of Victoria, Jack Smith and Happ. Earle of School and Dryer of Meds won their heat after a most gruelling race in which they trailed last until the final fifty yards, when they sprinted and won.

The famous Varsity eight was then formed, and a month later at the Canadian Henley in St. Catharines they defeated everything in sight. On the Friday, they defeated the Argonauts, Brockville, Hamilton and Ottawa , for the Junior championship of Canada, and on Saturday, the very next day, they won the Senior championship and the Hanlon Memorial, winning from Argos, Detroit, Ottawa and Chicago, by over four lengths. There were five School men in the crew—Boyd Little, Cliff Bennett, Jack Smith, Slim Bell and Doug. Huestis. The remainder were Coventry, Meds; Beatty, Arts, and Crighton of Victoria. Campbell, of Meds, was cox.

In the fall arrangements were made to hold inter-faculty races. School turned out so many candidates that the Argo clubhouse was nearly sunk. The final race was between School and Victoria. At the crack of the gun School jumped into the lead, and steadily increased it, winning by three lengths. The School crew were: Bell, McCabe, Jack Langford, Morris Ross, Beatty Ramsey, Wolsey and Brown. McGee, cox.

Indoor Baseball

School has always played a major part in the various athletic activities of the University. The case of indoor baseball has been no exception. Last year representatives from several faculties met and drew up a schedule for an Indoor Baseball League.

In this league School entered two teams, both of which played good ball, one team unfortunately meeting defeat at the hands of St. Michael's in the finals.

Last fall indoor ball enthusiasts met and formed a regular Indoor Baseball Club, similar to the Hockey and Basketball Clubs. A schedule for the Interfaculty League was then posted, with eight different faculties entering teams. Mr. Love, of Spalding's, donated a cup for the champions, which enlivened the league, and made the competition keener.

School again demonstrated its affinity for good sport in entering two teams: a Junior team, made up of first and second year men, with C. Williams I., as Manager, and a Senior team, made up of third and fourth year men, with G. Winters III. as Manager. The formation of two teams in this way somewhat handicapped School, but the snappy quality of ball played by both teams attracted much attention from the fans.

In Mummery, Senior School possessed a pitcher without a peer in the league. To his blinding speed is added a real ability with the bat and good baseball brains. The rest of the team backed him up well, and it was indeed unfortunate that they lost out to St. Mike's by 4-2, after tieing them for first place in Group B. Junior School also met the same fate by losing to Trinity in the finals for the leadership of Group A. Mutch, Baird and Williams were best for Junior School, and if Mutch, their first-rate pitcher, had only been able to pitch all their games, there is little doubt but that they would have won their group.

School contains much good material, and with this year's experience ought to turn out a crack team next year which will bring back the cup.

Senior Team—D. Brody, A. E. Rolph, T. M. Barry, C. R. Mummery, J. H. Westren, G. Winter, J. E. S. MacAllister, W. L. Yack, W. W. Fitzgerald, A. Johnston, G. M. Broughall.

Junior Team—J. C. Mutch, H. Baird, E. Baird, R. Morris, A. Duncan, G. Thompson, M. McQueen, R. Williamson, C. Williams, W. Boyes, W. B. Jennings, D. McKendrick, K. Griffin, G. W. Beecroft, P. Wheatley.

"School" and Squash

The present volume would be incomplete without some reference to the activities of "School" men in the sweat-soaked atmosphere of the squash courts. Those who have wandered idly through the maze of the lower regions of Hart House are familiar with the game. For the benefit of those who have not had this opportunity, and lest the idea of a well-known vegetable confuse the mind of the uninitiated, a brief description of the game follows:

The court has four walls, preferably at right angles to one

another, for simplicity. Some lines are painted on the walls and on the floor. Two stout fellows armed with a racquet each, and dressed as scantily as they please, smite a small and rather hard (depending on where it hits one) rubber ball round these walls. The server stands with one foot near a line on the floor and sends the ball above the wall lines. It is considered a foul for him to reverse the process and serve with one foot on the wall, onto the floor, as this unexpected mode of attack gives the server an unfair advantage over his opponent. Each time one misses the ball or makes a bad shot, one's opponent scores a point. The game goes to the one who scores fifteen points first. Beyond that there are few rules.

The game has a splendid appeal to the mathematical mind, an easy familiarity with the laws of ballistics and the science of Euclid, being a great asset. At first when the game started at Hart House, a policy of "brute strength and apostrophied ignorance" was followed by many, but it soon became apparent that it was really a game requiring the greatest skill and the finest co-operation of hand and eye, nerve and sinew. Under these conditions, it is not to be wondered at that School has come out strong, as usual. A good proportion of the regular players are School men, and on the Varsity team of four which played R. M. C., winning both here and at Kingston, School was ably represented. A challenge issued by the Victoria College Senior Common Room to anyone, was accepted first by a School team, which succeeded in winning.

The game is in its infancy at Varsity and is capable of great development. It is undoubtedly one of the finest games played, and we look forward confidently to a time not far distant when there will be many more courts, so made that unlimited fresh air can etner, thus overcoming the only drawback to our game as played in Hart House now.

U. of T. Billiards

Billiards is a game which has a fascination about it, as has anything about which there is a great deal to learn. To a great many people it is simply a case of "bang the balls around and trust to luck," but this is wrong. There is a science in billiards, which, if closely studied, involves very deep theory, and to the master mind probably Sir Isaac Newton's calculus may be introduced to solve some of the fine points of the game.

The Hart House Billiard Room at present contains eight tables, of which three are large English pocket billiards, two, small English tables, and three small tables, all of which are kept in the very best condition by two attendants of enviable ability. The chief attendant, Staff-Sergt. H. H. Roberts, Royal Grena-

diers, is a crack rifle shot. He won the championship of Canada in 1910, has been on the Bisley team three years, and is accompanying that team to England this year, where, no doubt, he will display his ability.

Among those who frequent this room there are many undergraduates who partake of a great deal of amusement studying the finer points of the game, and the social intercourse is uplifting. Of course there are a few obstreperous youths who insist on throwing the balls about in order to let the fellows know they are present, but under the splendid supervision of the Billiard Committee, members of which are Prof. W. F. Kennedy (Chairman), Dr. Perry, Dr. C. C. Imrie, Mr. John Jennings of the Faculty, Mr. G. A. Elliott II., M., Secretary, and at least one undergraduate from each of the faculties of U. of T., good order and discipline is maintained.

In order to prove to the students that there are many finer points in billiards, which are of great interest, and to give them an insight into some of these, arrangements were successfully made last November by the Committee with the Brunswick Balke Collender Co., of this city, to install a championship billiard table in the large gymnasium, where on the nights of November 5th and 6th, matches were played between Mr. E. F. Cooke, amateur champion of Ontario, and Mr. Luke E. Leonard, amateur champion of Ulster, Ireland, and Fort William, Ont.—2,000 points. Cooke, 2,000 Leonard, 1,395. High breaks, Cook, 155; Leonard, 76.

Following this demonstration, a tournament was arranged for the undergrads who take an interest in the game, to take place in the Billiard Room. There were about sixty entries, and during the various rounds some expert ability was displayed. Mr. W. B. MacDonald, of Dents, the winner, and Mr. W. T. R. Bell, of S.P.S., the runner-up, were awarded suitable prizes for their excellent display.

Shortly after the second term opened this was followed by a handicap tournament for the championship of Hart House Billiard Room. The handicaps were decided by the Committee from the individual scores on the preceding tournament. H. J. Philp, of III. Yr. S.P.S., was the winner, playing from scratch. Mr. W. J. Boyd, who had a "25-point in 200" handicap, was a close runner-up.

POSTSCRIPT

The Engineering Society

After a dormancy of fourteen years TRANSACTIONS is again appearing. From 1907 to 1916 its function was performed by the monthly, *Applied Science*; since then, however, "School" has had no publication aside from occasional issues of *Toike Oike.*

Of the achievements of the Engineering Society during this academic year, few will receive the honorable mention, at the hands of future historians, that will be accorded the reappearance of the TRANSACTIONS. As we view it to-day, their most important accomplishment has probably been in re-establishing the Engineering Society on a firm financial basis, but that, in itself, must dwindle in importance with time; posterity will be quick to discount and ready to forget, hence the coming generations of "School" men would be deprived of a clear view of probably the most illustrious year the Society has enjoyed. By publishing this volume, the Executive has successfully perpetuated its good work; it will remain as a model for future Executives, long after this one is gone. Never did a year start with so many difficulties ahead, and finish with such bright prospects for the future.

* * * *

No Apologies

The need for a publication of this nature had, of late, become acute. Enquiries from many pre-war subscribers, in different parts of the world, had been persistent; our own Alumni, we felt, would look with gratification on this connecting link binding them to happier, at all events, more care-free days, whilst we, the undergraduates, knew of no better way to line "School" up with the best of them. With these factors in view the Publication Committee set to work. The result of their efforts is in your hands. Do not be hasty in your judgment—not until you have made a survey of the problem as it faced them. The difficulties to be overcome were great. The phenomenal rise in the cost of publication, if not surprising, was, at least, aggravating, and lent no impetus to the scheme. The fact that none of the old Editors were with us to supply that wisdom derived only from experience, proved a great hindrance. Dealing with volunteer workers, men who receive no remuneration aside from the satisfaction of knowing that they have done their duty,

has its advantages, but also some serious drawbacks. The first setback the Publication Committee got came as a resignation of four of its members,—a deplorable incident. Happily, the increased efforts of the remainder were well able to carry it through.

We do not desire to apologize for any of the shortcomings (and there may be some) of this issue; we believe it to be, if not exactly what the Frenchman would call *de luxe*, at least fairly passable.

* * * *

Ye Editors

It is said that President Harding of the United States began his career as a newsboy. By dint of effort he became a printer's-devil, and finally Editor and publisher. Our Editor, though he is not eligible for the Presidency (not being thirty years old), is yet rapidly equipping himself for this honor. Being our chief, we dare not say much; we will but add that he has fulfilled the functions of an Editor, of a proofreader, of a printer's-devil, and, for all we know, he may be out at this moment, disposing of the copies.

We, being merely Managing Editor, are naturally exposed to much of the "menial," yet had it not been for the persistent help of our Editor, we would probably have had no need for this writing. Much praise is also due the Associate Editors, who unselfishly spent much effort to fill our advertising pages. Lastly, we wish to thank our advertisers for their generous response, and feel convinced that they will reap the benefits of their investment in a measure unhoped for.

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